Motion Control PMC

pilz
more than automation
safe automation

Communication profile PROFIBUS DP for PMCtendo DD4

User manual – Item No. 21 522-02

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Page

Contents . . . 3
Safety instructions . . . 5
Directives and standards . . . 6
CE -conformance . . . 6

Contents

1 General

2 Important
2.1 About this manual . . . 9

3 Installation / Setup
3.1 Hard- and Software installation . . . 11
3.1.1 Parameterization of the master-interface modules . . . 12
3.1.1.1 Configuration of the control . . . 12
3.1.2 Standard functions for data exchange with PMCtendo DD4 . . . 13
3.2 Setup . . . 13
3.2.1 Setup of the basic functions of the servo amplifier . . . 13

4 Profile of PMCtendo DD4
4.1 Parameter channel . . . 16
4.1.1 Parameter ID (PKE) . . . 16
4.1.1.1 Interpretation of the response IDs . . . 16
4.1.1.2 Profile-specific error numbers with response ID 7 . . . 17
4.1.2 Subindex IND . . . 17
4.1.3 Parameter value PWE . . . 18
4.2 The process data channel . . . 18

5 Using the parameter channel
5.1 Read/write an amplifier parameter . . . 19
5.2 Summary of the parameter numbers . . . 19
5.2.1 List of the parameter numbers . . . 19
5.2.2 Profile parameters . . . 22
5.2.2.1 PNU 904/911: PPO-type write/read . . . 22
5.2.2.2 PNU 918: PROFIBUS - node addresse . . . 22
5.2.2.3 PNU 930: selector for operating modes . . . 23
5.2.2.4 PNU 963: baud rate . . . 24
5.2.2.5 PNU 965: PROFIDRIVE profile number . . . 24
5.2.2.6 PNU 970: default parametersr . . . 24
5.2.2.7 PNU 971: non-volatile saving of parameters . . . 24
5.2.3 General parameters . . . 25
5.2.3.1 PNU 1000: instrument ID . . . 25
5.2.3.2 PNU 1001: manufacturer-specific error register . . . 25
5.2.3.3 PNU 1002: manufacturer-specific status register . . . 26
5.2.4 Position controller parameters . . . 27
5.2.4.1 PNU 1250: velocity multiplier . . . 27
5.2.4.2 PNU 1251: axis type . . . 27
5.2.5 Position data for the position-control mode . . . 27
5.2.5.1 PNU 1300: position . . . 27
5.2.5.2 PNU 1301: velocity . . . 27
5.2.5.3 PNU 1302: motion task type . . . 28
5.2.5.4 PNU 1304: acceleration time . . . 28
5.2.5.5 PNU 1305: deceleration time . . . 28
5.2.5.6 PNU 1306: acceleration jolt limiting . . . 29
5.2.5.7 PNU 1307: deceleration jolt limiting . . . 29
5.2.5.8 PNU 1308: next motion task . . . 29
5.2.5.9 PNU 1309: start delay . . . 29
5.2.5.10 PNU 1310: copy motion task . . . 29
5.2.5.11 PNU 1311: Position, 32 Bit floating decimal point format . . . 29
5.2.5.12 PNU 1312: Velocity, 32 Bit floating decimal point format . . . 29
5.2.6 Setup mode: position . . . 30
5.2.6.1 PNU 1350: homing . . . 30
5.2.6.2 PNU 1351: homing direction . . . 30
5.2.7 Actual values . . . 30
5.2.7.1 PNU 1401: speed . . . 30

Page

5.2.7.2 PNU 1402: incremental position: actual value . . . 30
5.2.7.3 PNU 1403: SI-position: actual value . . . 30
5.2.7.4 PNU 1414: Actual position, 32 Bit floating decimal point format . . . 30
5.2.7.5 PNU 1415: Actual velocity, 32 Bit floating decimal point format . . . 31
5.2.8 Digital I/O-configuration . . . 31
5.2.8.1 PNU 1450 .. 1453: function of the digital inputs . . . 31
5.2.8.2 PNU 1458/1459: function of the digital outputs . . . 32
5.2.9 Analog configuration . . . 32
5.2.9.1 PNU 1500: configuration of the analog input functions . . . 32
5.2.9.2 PNU 1501/1506: configuration of the analog outputs . . . 32
5.2.10 Manufacturer specific object channel (from PNU 1600) . . . 33

6 Process data channel

6.1 Instrument control . . . 35
6.1.1 Control word (STW) . . . 38
6.1.2 Status word (ZSW) . . . 39
6.2 Operating modes . . . 39
6.2.1 Positioning (operating mode 2) . . . 40
6.2.2 Digital speed (operating mode 1) . . . 41
6.2.3 Analog speed (operating mode -1) [in preparation] . . . 41
6.2.4 Digital torque (operating mode -2) . . . 42
6.2.5 Analog torque (operating mode -3) [in preparation] . . . 42
6.2.6 Electronic gearing (operating mode -4) . . . 42
6.2.7 ASCII-channel (operating mode -16) . . . 43
6.2.8 Initial setting after switch-on (operating mode -126) . . . 43

7 Setup software

7.1 Screen page PROFIBUS . . . 45
7.2 Screen page PROFIBUS instrument control . . . 46

8 Sample telegrams

8.1 Important communication parameter . . . 47
8.2 Zero telegram . . . 48
8.3 Setting the operating mode . . . 48
8.4 Enable the PMCtendo DD4 . . . 49
8.5 Start jog mode . . . 49
8.6 Set reference point . . . 49
8.7 Start homing run . . . 50
8.8 Start a motion task . . . 52
8.9 Start a direct motion task . . . 52
8.10 Polling a warning or error message . . . 52
8.11 Writing a parameter . . . 53
8.12 Read actual values . . . 53
8.13 Write a parameter via the ASCII channel . . . 54

9 Appendix

10 Index

Safety instructions

- **Only properly qualified personnel is permitted to carry out activities such as transport, installation, setup and maintenance. Properly qualified persons are those who are familiar with transport, installation, assembly, setup and operation of the products, and who have the appropriate qualifications for their job. The qualified personnel must know and observe the following directives and standards:**
  IEC 364 and CENELEC HD 384 or DIN VDE 0100
  IEC-Report 664 or DIN VDE 0110
  national accident prevention regulations or BGV A2

- **Read all the documentation for the servo amplifier before carrying out installation and setup. Incorrect handling of the servo amplifier can lead to injury to persons or material damage. It is vital that you keep to the technical data and information on connection requirements (nameplate and documentation).**

- **The manufacturer of the machine must generate a hazard analysis for the machine, and take appropriate measures to ensure that unforeseen movements cannot cause injury or damage to any person or property.**

- **The servo amplifiers contain electrostatically sensitive components, that may be damaged by incorrect handling. Discharge your body before touching the servo amplifier. Avoid contact with highly insulating materials (artificial fabrics, plastic films etc.). Place the servo amplifier on a conductive surface.**

- **Do not open the units. Keep all covers and switchgear cabinet doors closed during operation. Otherwise there are deadly hazards with the possibility of severe damage to health or property.**

- **Depending on the degree of enclosure protection, servo amplifiers can have hot surfaces, and bare components that are live. Control and power cables may carry a high voltage, even when the motor is not rotating.**

- **Servo amplifiers may have hot surfaces during operation. Since the front panel is used for cooling, it can reach temperatures above 80°C (176°F).**

- **Never undo the electrical connections of the servo amplifier when it is live. In unfavorable circumstances this can produce electrical arcing that is damaging both to persons and the equipment.**

- **Wait at least two minutes after disconnecting the servo amplifier from the supply voltage, before touching any normally live sections of the equipment (e.g. contacts, screwed connections) or undoing connections. Capacitors can have dangerous voltages present up to two minutes after switching off the supply voltages. To be sure, measure the voltage in the intermediate circuit (DC-link) and wait until it has fallen below 40V.**

Eurpoean directives and standards

Servo amplifiers are components that are intended to be incorporated into electrical machines and plant. When the servo amplifiers are incorporated into machines or plant, the intended operation of the servo amplifier is forbidden until it has been established that the machine or plant fulfills the requirements of the EC Machinery Directive 98/37/EEC and the EC EMC Directive (89/336/EEC). EN 60204 and EN 292 must also be observed.
The manufacturer of the machine must generate a hazard analysis for the machine, and take appropriate measures to ensure that unforeseen movements cannot cause injury or damage to any person or property.

In connection with the Low Voltage Directive 73/23/EEC, the harmonized standards of the EN 50178 series are applied to the servo amplifiers, together with EN 60439-1, EN 60146 and EN 60204.
The manufacturer of the machine or plant is responsible for ensuring that the machine or plant meets the limits that are laid down by the EMC regulations. Advice on the correct installation for EMC – such as shielding, grounding, arrangement of filters, handling of connectors and laying out the cabling – can be found in the assembly and installation instructions for the servo amplifier.

CE - conformance

Conformance with the EC Directive on EMC 89/336/EEC and the Low Voltage Directive 73/23/EEC is mandatory for the supply of servo amplifiers within the European Community.
The servo amplifiers of the series have been tested by an authorized testing laboratory in a defined configuration with the system components which are described in this documentation. Any divergence from the configuration and installation described in this documentation means that you will be responsible for the performance of new measurements to ensure that the regulatory requirements are met.

UL and cUL- Conformance

UL (cUL)-certified servo amplifiers (Underwriters Laboratories Inc.) fulfil the relevant U.S. and Canadian standard (in this case UL 840 and UL 508C).
This standard describes the fulfilment by design of minimum requirements for electrically operated power conversion equipment, such as frequency converters and servo amplifiers, which is intended to eliminate the risk of fire, electric shock, or injury to persons, being caused by such equipment. The technical conformance with the U.S. and Canadian standard is determined by an independent UL (cUL) inspector through the type testing and regular check-ups.
Apart from the notes on installation and safety in the documentation, the customer does not have to observe any other points in direct connection with the UL (cUL)-certification of the equipment.

UL 508C

UL 508C describes the fulfilment by design of minimum requirements for electrically operated power conversion equipment, such as frequency converters and servo amplifiers, which is intended to eliminate the risk of fire being caused by such equipment.

UL 840

UL 840 describes the fulfilment by design of air and insulation creepage spacings for electrical equipment and printed circuit boards.

Abbreviations used in this manual

The abbreviations used in this manual are explained in the table below.

Abbrev.	Meaning
AGND	Analog ground
AS	Restart Lock, option
BTB/RTO	Ready to operate
CAN	Fieldbus (CANopen)
CE	Communité Européenne (EC)
CLK	Clock signal
COM	Serial interface for a PC-AT
DGND	Digital ground
DIN	German Institute for industrial Standards
Disk	Magnetic storage (diskette, hard disk)
EEPROM	Electrically erasable programmable memory
EMC	Electromagnetic compatibility
EMI	Electromagnetic interference
EN	European standard
ESD	Electrostatic discharge
IEC	International Electrotechnical Commission
IGBT	Insulated Gate Bipolar Transistor
INC	Incremental Interface
ISO	International Standardization Organization
LED	Light-emitting diode
MB	Megabyte
MS-DOS	Operating system for PC-AT

Abbrev	Meaning
NI	Zero pulse
NSTOP	Limit-switch input for CCW rotation (left)
PC-AT	Personal computer with 80x86 Processor
PELV	Protected low voltage
PGND	Ground for the interface
PSTOP	Limit-switch input for CW rotation (right)
PWM	Pulse-width modulation
RAM	Volatile memory
Rregen	Regen resistor
RBext	External regen resistor
RBint	Internal regen resistor
RES	Resolver
ROD 426	A quad B encoder
PLC	Programmable logic controller
SRAM	Static RAM
SSI	Synchronous serial interface
SW/SETP.	setpoint
UL	Underwriters Laboratory
VAC	AC voltage
VDC	DC voltage
VDE	Verein deutscher Elektrotechniker
XGND	Ground for the 24V supply

Symbols used in this manual

	danger to personnel from electricity and its effects			general warning general instructions mechanical hazard
⇨ p.	see page (cross-ref.)		●	special emphasis

Keys on the servo amplifier panel :	
▲	**press once** : move up one menu item, increase number by one **press twice in rapid succession** : increase number by ten
▼	**press once** : move down one menu item, decrease number by one **press twice in rapid succession** : decrease number by ten
▲ ▼	**hold right key pressed, and then press left key as well** : to enter number, “Return” function

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1 General

2 Important

2.1 About this manual

This manual describes the wiring, setup, range of functions and software protocol for the PMCtendo DD4. It is part of the complete documentation of the PMCtendo DD4 family of digital servo amplifiers.

The installation and setup of the servo amplifier, as well as all the standard functions, are described in the corresponding manuals.

Further documentation for the PMCtendo DD4 series:

Installation manual PMCtendo DD4
User manual PDrive

This manual is intended for the use of qualified personnel with the following knowledge:

Wiring:	**trained electro-technical personnel**
Programming:	**experienced PLC programmers with PROFIBUS DP expertise**

The required files for the drive handling blocks can be found in the folder "fieldbus\Profibus\Profibus for tendo DD4" of the "Motion Control Tools"-CD ROM.

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3 Installation / Setup

3.1 Hard- and Software installation

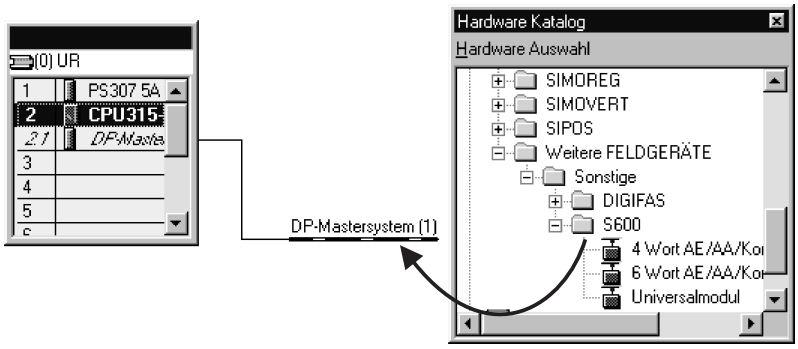
Install and wire up the equipment only while it is electrically dead. Make sure that the switchgear cabinet is safely isolated (lock-out, warning signs etc.).
The individual supply voltages will not be switched on until setup is carried out.
Residual charges in the capacitors can still have dangerous levels several minutes after switching off the supply voltage. Measure the voltage in the intermediate (DC-link) circuit and wait until it has fallen below 40V.
Power and control connections can still be live, even though the motor is not rotating.
Electronic equipment is basically not failure-proof. The user is responsible for ensuring that, in the event of a failure of the servo amplifier, the drive is set to a state that is safe for both machinery and personnel, for instance with the aid of a mechanical brake.
Drives with servo amplifiers and PROFIBUS expansion cards are remote-controlled machines. They can start to move at any time without previous warning. Take appropriate measures to ensure that the operating and service personnel is aware of this danger.
Implement appropriate protective measures to ensure that any unintended start-up of the machines cannot result in dangerous situations for personnel or machinery. Software limit-switches are not a substitute for the hardware limit-switches in the machine.

Install the servo amplifier as described in the installation manual. The wiring for the analog setpoint input and the positioning interface, as shown in the wiring diagram in the installation manual, is not required.
Use the valid connection diagram in the amplifier installation manual for the connection to a PROFIBUS network.
Never break any of the electrical connections to the servo amplifier while it is live. This could result in destruction of the electronics. Because of the internal representation of the position-control parameters, the position controller can only be operated if the final limit speed of the drive at sinusoidal² commutation is not more than 7500 rpm. At trapezoidal commutation, the permitted maximum speed is 12000 rpm. All the data on resolution, step size, positioning accuracy etc. refer to calculatory values. Non-linearities in the mechanism (backlash, flexing, etc.) are not taken into account.
If the final limit speed of the motor has to be altered, then all the parameters that were previously entered for position control and motion blocks must be adapted.

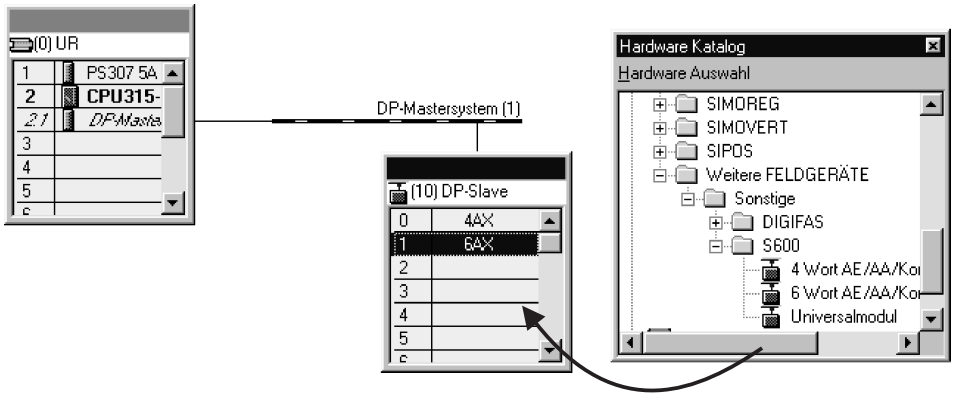
3.1.1 Parameterization of the master-interface modules

3.1.1.1 Configuration of the control

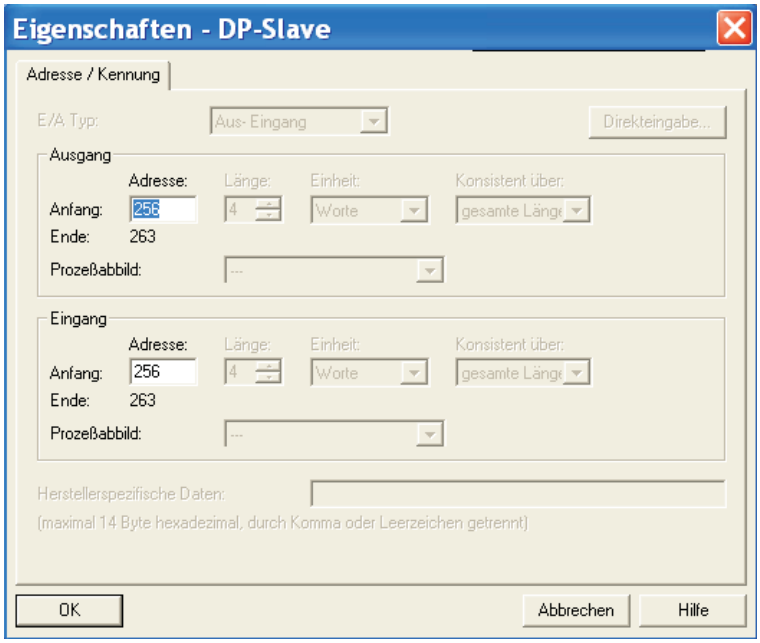
The graphics interface makes it very easy to configure the Siemens S7 for the PROFIBUS network. After you have set up the control layout, configure the interface module that is used as follows: Use our library file **DD4_045D.GSD** for the planning. Open the Hardware catalog and drag the symbol for the corresponding field unit onto the representation of the bus system. A window opens automatically for the general parameterization of the field unit. Enter the address of the participant here.



Next, use the same method as above to drag the module from the Hardware catalog into the box for the field unit, whereby the 4-word module must lie in Cell 0 and the 6-word module in Cell 1.



Another window opens, in which you can set the parameters for the module.



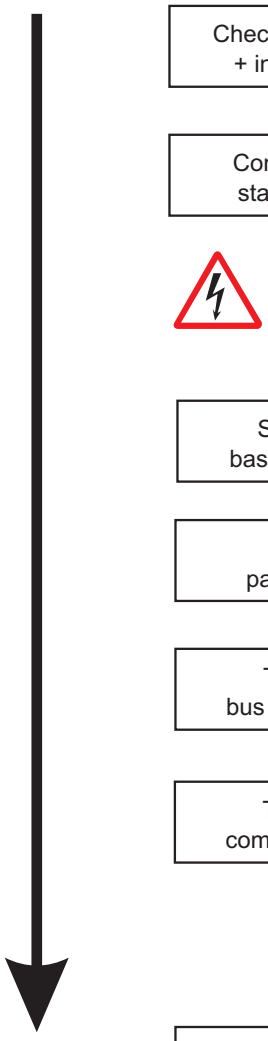
3.1.2 Standard functions for data exchange with PMCtendo DD4

Pilz supplies a function block package (DRIVE_FC). The function block package includes a number of function blocks that make it possible to handle PMCtendo DD4 control functions very simply.
A description of the individual function blocks can be found as a pdf file on the CD-ROM.

3.2 Setup

3.2.1 Setup of the basic functions of the servo amplifier

Only properly qualified personnel with professional expertise in control and drive technology are permitted to setup the servo amplifier.



Check assembly + installation

Check that all the safety instructions, which are included in both the installation manual for the servo amplifier and in this manual, have been observed and implemented.

Connect PC, start PDrive

Use the setup Software PDrive for setting the parameters for the servo amplifier.

Caution!
Make sure that any unintended movement of the drive cannot create a danger to personnel or machinery.

Setup the basic functions

Now setup the basic functions of the servo amplifier and optimize the current and speed controllers. This part of setup is described in the “Quickstart” setup manual.

Save parameters

When the optimization is finished, save the controller parameters in the servo amplifier.

Test the bus connection

Remove the Enable signal (Terminal X3.16) and switch off the power supply for the servo amplifier.
The 24V DC auxiliary voltage remains switched on.

Test the communication

Test the installation of the PROFIBUS connection and the interface for the PROFIBUS master.
Check the PROFIBUS-DP parameter settings and the station configuration.
Check the parameter settings for the PROFIBUS interface module.
Check the PLC user program and the parameter settings for the function block packages.

Setup the position controller

Setup the position controller, as described in the “Quickstart” setup manual.

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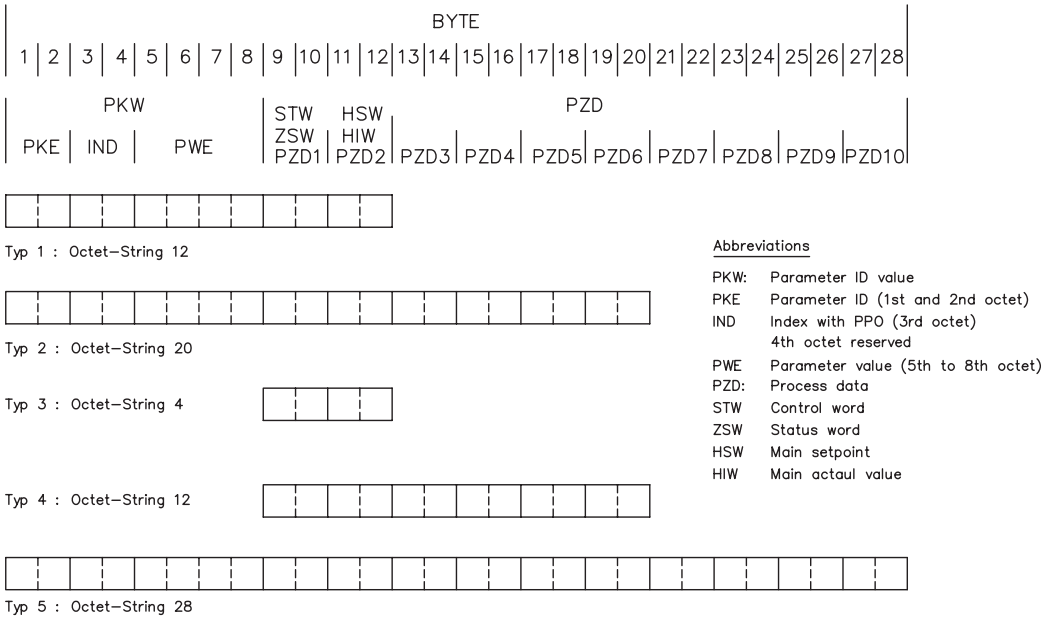
4 Profile of PMCtendo DD4

The PROFIBUS-profile PROFIDRIVE includes the following parameter process-data objects (PPO):


BYTE
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28
PKW
PKE IND PWE
STW HSW
ZSW HIW
PZD1 PZD2
PZD
PZD3 PZD4 PZD5 PZD6 PZD7 PZD8 PZD9 PZD10
Typ 1 : Octet–String 12
Typ 2 : Octet–String 20
Typ 3 : Octet–String 4
Typ 4 : Octet–String 12
Typ 5 : Octet–String 28
Abbreviations
PKW: Parameter ID value
PKE Parameter ID (1st and 2nd octet)
IND Index with PPO (3rd octet)
4th octet reserved
PWE Parameter value (5th to 8th octet)
PZD: Process data
STW Control word
ZSW Status word
HSW Main setpoint
HIW Main actaul value

PMCtendo DD4 only uses the PPO-type 2 (with 4 words PKW-section and 6 words PZD-section). The PKW-section is used mainly for the transmission of parameters for the servo amplifier, the PZD-section is used principally for handling motion functions.

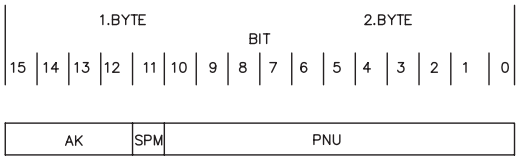
The instrument profile can be divided into two sections or data channels:
1. PKW-section (4 words)
2. PZD-section (6 words)

The PKW data channel can also be termed the service channel. The service channel only uses confirmed communication services, and is used by PMCtendo DD4 as a parameter channel.
This channel has no real-time capability.

The PZD data channel can also be termed the process data channel. The process data channel uses unconfirmed communication services. The response of the servo amplifier to an unconfirmed service can only be seen in the reaction of the instrument (status word, actual values).
This channel has real-time capability.

4.1 Parameter channel

4.1.1 Parameter ID (PKE)



Abbreviations

AK	task / response ID
SPM	Toggle-Bit for spontaneous message (not implemented at present)
PNU	Parameter number

Bold lines in the table are valid for PMCtendo DD4

Master —> Slave		Slave —> Master	
Task ID	**Function**	**Response ID positive**	**Response ID negative**
0	**no task**	**0**	**0**
1	**request parameter value**	1,**2**	**7**
2	alter parameter value [W]	1	7/8
3	**alter parameter value [DW]**	**2**	**7**/8
4	request description element	3	7
5	alter description element	3	7/8
6	request parameter value [A]	4,5	7
7	alter parameter value [A/W]	4	7/8
8	alter parameter value	5	7/8
9	request number of array elements	6	7
10 - 15	reserved		

4.1.1.1 Interpretation of the response IDs

Response ID	Interpretation
0	**no task**
1	transmit parameter value
2	**transmit parameter value**
3	transmit description element
4	transmit parameter value
5	transmit parameter value
6	transmit number of array elements
7	**task not possible (with error no.)**
8	no operating authority for PKW interface
9	spontaneous message [W]
10	spontaneous message [DW]
11	spontaneous message [A/W]
12	spontaneous message [A/DW]

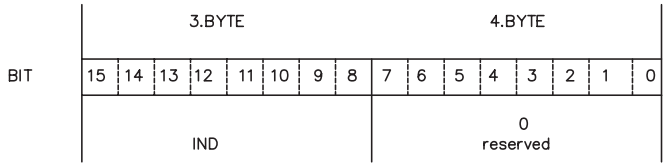
Abbreviatoins in the tables:

A: Array
W: Word
DW: Double-word

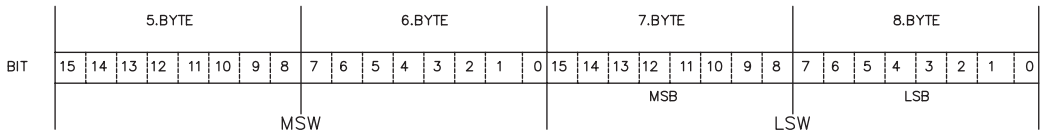
4.1.1.2 Profile-specific error numbers with response ID 7

Error no.	Description
0	**illegal PNU**
1	**parameter value cannot be changed**
2	**Lower or upper limit violated**
3	**Erroneous sub-index**
4	**no array**
5	**Incorrect data type**
6	**setting not allowed (can only be reset)**
7	Descriptive element cannot be changed
8	PPO-write, requested in IR, not available
9	descriptive data not available
10	access group incorrect
11	No parameter change rights
12	Password incorrect
13	Text cannot be read in cyclic data transmission
14	Name cannot be read in cyclic data transmission
15	text array not available
16	PPO-write missing
17	**task cannot be executed due to operating status**
18	**other error**
19-100	**reserved**
101	**faulty task ID**
102	**software error (command table)**
103	**only possible in disabled state**
104	**only possible in enabled state**
105	**BCC-error in the EEPROM data**
106	**only possible after task is stopped**
107	**wrong value [16,20]**
108	**wrong parameter (OCOPY x [- y] z)**
109	**wrong motion block no. (0,1..180,192..255)**
110	**wrong parameter (PTEACH x [y])**
111	**EEPROM write error**
112	**wrong value**
113	**BCC-error in motion block**
114	**Object is read only or write only**
115	**Incompatible object (SDO channel only)**
>115	**reserve**

4.1.2 Subindex IND



4.1.3 Parameter value PWE



The data for the PNU-variable is contained in the PWE, and is placed flush right:

4-byte data (double-word) PWE 5-8 (PWE 8 LSB)

Commands are transferred with task ID 3. If a command cannot be executed, the response identification AK = 7 signals the error, and an error number is given out. The error numbers are described on page 17.

4.2 The process data channel

Cyclical data are exchanged across the PROFIBUS through the process data section of the 20-byte telegram. Each PROFIBUS cycle triggers an interrupt in the PMCtendo DD4. This has the effect that new process data are exchanged and processed. The interpretation of these process data depends on the operating mode that is set. The operating mode is set through a PROFIBUS parameter (PNU 930, ⇨ p. 23).

In all operating modes, the data word 1 of the process data (PZD1) in the direction from control system -> PMCtendo DD4 is used for instrument control, and in the direction from PMCtendo DD4 -> control system it has the function of a status indicator for the drive.

The interpretation of the process data PZD2 – PZD6 changes, depending on the operating mode, as can be seen in Chapter 6.2.

Caution:
When the PMCtendo DD4 is switched on, the operating mode that is set is always –126 (safe state). Before changing the operating mode, bit 10 of the control word STW must always be set to 0. The new operating mode only becomes active when bit 10 of the control word is set to 1.

5 Using the parameter channel

The digital servo amplifiers of the PMCtendo DD4 series have to be adapted to the circumstances of your machine. The parameters for the controllers are set using either the setup Software PDrive or via the PROFIBUS.

5.1 Read/write an amplifier parameter

Read (AK = 1) or write (AK = 3) amplifier parameters

To read or write an amplifier parameter, which is recognized by the parameter number (PNU), to the *volatile* memory of the PMCtendo DD4. The parameters that are stored in the PMCtendo DD4 can be transferred to the *non-volatile* memory by using the command "non-volatile parameter save" (PNU 971).

Telegram layout:

	Request	**Response**
PKE/AK	1 (read) / 3 (write)	2 (OK) / 7 (error)
PKE/PNU	see 5.2.1	as transmitted
PWE	for AK = 3 see 5.2.1 for data type for AK = 1 data type irrelevant	for AK = 3 returns the PWE of the request for AK = 1 see 5.2.1 for data type

5.2 Summary of the parameter numbers

All the parameter numbers for PMCtendo DD4 are listed in numerical order in the table in Chapter 5.2.1, with a short description. The parameter numbers in the range 900 – 999 are profile-specific for the PROFIBUS drive profile PROFIDRIVE. Parameter numbers > 999 are manufacturer- specific.
For better understanding, you can look up the ASCII commands which are in the column "PMCtendo DD4 ASCII command" in the user manual for the Setup Software PDrive.
This section deals only with parameters that refer to the PROFIBUS expansion card and have not already been described in the setup software manual. The attachment runs via the ASCII-commands.

5.2.1 List of the parameter numbers

PNU	**Data type**	**Access**	**Description**	**PMCtendo DD4 ASCII command**
Profile parameter				
904	UINT32	ro	Number of the supported PPO-write, always 2	-
911	UINT32	ro	Number of the supported PPO-read, always 2	-
918	UINT32	ro	Participant address on PROFIBUS	ADD
930	UINT32	r/w	Selector for operating mode	-
963	UINT32	ro	PROFIBUS baud rate	-
965	Octet-String2	ro	Number of the PROFIDRIVE profile (0302H)	-
970	UINT32	wo	Load default parameter set	RSTVAR
971	UINT32	wo	non-volatile parameter save	SAVE
1204	UINT32	r/w	Setpoint ramp-, speed controller	DEC
1205	UINT32	r/w	Emergency stop ramp, speed controller	DECSTOP
1206	UINT32	r/w	Maximum speed	VLIM
1207	UINT32	r/w	Overspeed	VOSPD
1208	UINT32	r/w	Count direction	DIR

PNU	Data type	Access	Description	PMCtendo DD4 ASCII command
Manufacturer-specific parameters PMCtendo DD4				
General parameters				
1000	Visible String4	ro	Instrument ID	-
1001	UINT32	ro	Manufacturer-specific error register	ERRCODE
1002	UINT32	ro	Manufacturer-specific status register	-
Speed controller parameters				
1200	UINT32	r/w	K_p – gain factor for speed controller	GV
1201	UINT32	r/w	T_n – integral-action time for speed controller	GVTN
1202	UINT32	r/w	PID – T_2 – time constant for speed controller	GVT2
1203	UINT32	r/w	Setpoint ramp+, speed controller	ACC
1204	UINT32	r/w	Setpoint ramp-, speed controller	DEC
1205	UINT32	r/w	Emergency stop ramp, speed controller	DECSTOP
1206	UINT32	r/w	Maximum speed	VLIM
1207	UINT32	r/w	Overspeed	VOSPD
1208	UINT32	r/w	Count direction	DIR
Position controller parameters				
1250	UINT32	r/w	Velocity multiplier for jogging/homing	VMUL
1251	UINT32	r/w	Axis type	POSCNFG
1252	INTEGER32	r/w	InPosition window	PEINPOS
1253	INTEGER32	r/w	Contouring error window	PEMAX
1254	INTEGER32	r/w	Position register 1	SWE1
1255	INTEGER32	r/w	Position register 2	SWE2
1256	INTEGER32	r/w	Position register 3	SWE3
1257	INTEGER32	r/w	Position register 4	SWE4
1258	UINT32	r/w	Denominator resolution	PGEARO
1259	UINT32	r/w	Numerator resolution	PGEARI
1260	UINT32	r/w	Minimum acceleration/braking time	PTMIN
1261	UINT32	r/w	Feed-forward factor for position controller	GPFFV
1262	UINT32	r/w	K_V - factor for position controller	GP
1263	UINT32	r/w	K_P - factor for position controller	GPV
1264	UINT32	r/w	T_n - integral-action time for position controller	GPTN
1265	UINT32	r/w	Maximum velocity for positioning mode	PVMAX
1266	UINT32	r/w	Configuration variable for software switch	SWCNFG
1267	UINT32	r/w	Configuration variable 2 for software switch	SWCNFG2
Position data for the position control mode				
1300	INTEGER32	r/w	Position	O_P
1301	INTEGER16	r/w	Velocity	O_V
1302	UINT32	r/w	Motion task type	O_C
1304	UINT32	r/w	Starting time (acceleration)	O_ACC1
1305	UINT32	r/w	Braking time (deceleration)	O_DEC1
1306	UINT32	r/w	Jolt limiting (acceleration)	O_ACC2
1307	UINT32	r/w	Jolt limiting (deceleration)	O_DEC2
1308	UINT32	r/w	Number of next motion task	O_FN
1309	UINT32	r/w	Start delay for next motion task	O_FT
1310	2 * UINT16	wo	Copy a motion task	OCOPY
Position set-up mode				
1350	UINT32	r/w	Homing type	NREF
1351	UINT32	r/w	Homing direction	DREF
1352	UINT32	r/w	Acceleration ramp (jogging/homing)	ACCR
1353	UINT32	r/w	Braking ramp	DECR
1354	UINT32	r/w	Reference offset	ROFFS
1355	UINT32	ro	Homing run velocity	VREF
1356	UINT32	ro	Jogging velocity	VJOG

PNU	Data type	Access	Description	PMCtendo DD4 ASCII command
Actual values				
1400	INTEGER32	ro	Actual position 20 bits/turn	PRD
1401	INTEGER32	ro	Speed	
1402	INTEGER32	ro	Incremental position, actual value	
1403	INTEGER32	ro	SI-position, actual value	PFB
1404	INTEGER32	ro	SI-velocity, actual value	PV
1405	INTEGER32	ro	SI contouring error	PE
1406	INTEGER32	ro	RMS current	I
1407	INTEGER32	ro	SI-speed, actual value	V
1408	INTEGER32	ro	Heatsink temperature	TEMPH
1409	INTEGER32	ro	Internal temperature	TEMPE
1410	INTEGER32	ro	DC-bus (DC-link) voltage	VBUS
1411	INTEGER32	ro	Ballast power	PBAL
1412	INTEGER32	ro	I^2t - loading	I2T
1413	INTEGER32	ro	Running time	TRUN
Digital I/O configuration				
1450	UINT32	r/w	Function of digital input 1	IN1MODE
1451	UINT32	r/w	Function of digital input 2	IN2MODE
1452	UINT32	r/w	Function of digital input 3	IN3MODE
1453	UINT32	r/w	Function of digital input 4	IN4MODE
1454	INTEGER32	r/w	Auxiliary variable for digital input 1	IN1TRIG
1455	INTEGER32	r/w	Auxiliary variable for digital input 2	IN2TRIG
1456	INTEGER32	r/w	Auxiliary variable for digital input 3	IN3TRIG
1457	INTEGER32	r/w	Auxiliary variable for digital input 4	IN4TRIG
1458	INTEGER32	r/w	Function of digital input 1	O1MODE
1459	INTEGER32	r/w	Function of digital input 2	O2MODE
1460	UINT32	r/w	Auxiliary variable for digital output 1	O1TRIG
1461	UINT32	r/w	Auxiliary variable for digital output 2	O2TRIG
1462	UINT32	r/w	State of four digital inputs, Enable, 2 digital outputs	STATIO
Analog configuration				
1500	UINT32	r/w	Configuration of the analog input functions	ANCNFG
1501	UINT32	r/w	Configuration monitor function analog output 1	ANOUT1
1502	UINT32	r/w	Offset voltage for analog input 1	ANOFF1
1503	UINT32	r/w	Filter time constant for analog input 1	AVZ1
1504	UINT32	r/w	Scaling factor for velocity, analog input 1	VSCALE1
1505	UINT32	r/w	Scaling factor for current, analog input 1	ISCALE1
1506	UINT32	r/w	Configuration monitor function analog output 2	ANOUT2
1507	UINT32	r/w	Offset voltage for analog input 2	ANOFF2
1508	UINT32	r/w	Scaling factor for velocity, analog input 2	VSCALE2
1509	UINT32	r/w	Scaling factor for current, analog input 2	ISCALE2
Motor parameters				
1550	UINT32	r/w	Brake configuration	MBRAKE
1551	UINT32	r/w	Motor number from motor database	MNUMBER
Manufacturer specific object channel				
≥1600	⇒ p. 33 and description of the ASCII-commands on the CD-rom (4th quarter 2002).			

Abbreviations in the “Access” column

The “Access” column shows which type of access (e.g read/write) is possible via the bus.

Abbrev.	Description
wo	“write only” access
ro	“read only” access
r/w	read/write access

5.2.2 Profile parameters

5.2.2.1 PNU 904/911: PPO-type write/read

These parameters describe the numbers of the supported PPO-types write und read.
Since only PPO-type 2 is supported (see Chapter 4), this parameter is always set to 2.

5.2.2.2 PNU 918: PROFIBUS - node addresse

With this parameter the PROFIBUS - node address of the drive can be read.

You can alter the node address (station addres in a PROFIBUS network) in different ways:

- With the keys in the front panel (see installation manual)
- With the setup software PDrive on the screen page "Basic setup"
- Via the serial interface with the sequence of ASCII-commands:
  ADDR nn ⇒ SAVE ⇒ COLDSTART (mit nn = Adresse)

The range of addresses can be extended from 1..63 to 1..127 with the ASCII-command MDRV.

5.2.2.3 PNU 930: selector for operating modes

The “Selector for operating modes” is defined by the drive profile, and mirrors the operating modes of the drive profile to the operating modes of the PMCtendo DD4. The following table shows a summary of the operating modes:

Caution!
If process data are exchanged across the PROFIBUS, then the operating modes of the drive profile must only be selected with PNU 930.

Operating mode of drive profile	Operating mode PMCtendo DD4 (ASCII command “OPMODE”)	Description
2	8	Positioning mode according to PROFIDRIVE profile
1	0	Digital speed control according to PROFIDRIVE profile
0	-	reserved
-1	1	Speed control, analog setpoint provision (in preparation)
-2	2	Torque control, digital setpoint provision
-3	3	Torque control, analog setpoint provision (in preparation)
-4	4	Position control, electronic gearing
-5	5	Position control, external trajectory (in preparation)
-6 to -15	-	reserved
-16	-	ASCII channel for expanded parameterization
-17 to -125	-	reserved
-126	-	Initial settings when instrument is switched on

The individual operating modes are described in Chapter 6.2. A change of operating mode can only be undertaken in connection with the control word.

The operating mode must be changed according to the following sequence:

1. **Inhibit setpoints and process data**
   Bit 10 in the control word is set to 0, so that no new setpoints will be accepted by the servo amplifier and no new control functions can be initiated. A new operating mode can, however, be selected while a motion function is being performed.
   The control word is only inhibited to the extent that the servo amplifier can always be switched into a safe state.
2. **Select the new operating mode with PNU 930**
   The new operating mode is selected with parameter 930 through the parameter channel, but not yet accepted.
3. **Set/receive the setpoints and actual values**
   Enter the corresponding setpoints in the setpoint area of the process data.
   Here you must take note that the normalization and data formats depend on the operating mode that is selected. The interpretation of the actual values is also altered (see Chapter 5.2.2.3). The user program must respond accordingly.
4. **Enable the setpoints**
   Bit 10 of STW is set to 1. The setpoints are immediately accepted and processed.
   The new actual values are output with the appropriate normalization and data format.

Caution
In the safe operating mode (-126), no motion functions can be initiated via the PROFIBUS. However, it is possible to perform motion functions with the aid of the setup Software.
If the operating mode is changed, then motion functions can only be operated via the PROFIBUS. If the operating mode is changed via another communication channel, then the drive is emergency braked and the error F21 (Handling error, plug-in card) is signaled.

5.2.2.4 PNU 963: baud rate

This parameter defines the index of the baud rate that is used for PROFIBUS communication, and can only be read. The baud rate is given out by the PROFIBUS-master.
The table below shows the indices with the according baud rates:

Index	0	1	2	3	4	5	6	7	8	9
Baud rate	12000	6000	3000	1500	500	187.5	93.75	45.45	19.2	9.6

5.2.2.5 PNU 965: PROFIDRIVE profile number

This parameter can be used to read out the number of the PROFIDRIVE profile. Profile Number 3, Version 2 is used.

5.2.2.6 PNU 970: default parametersr

With this parameter you can reject all the parameters that are set and load the manufacturer's default values.

5.2.2.7 PNU 971: non-volatile saving of parameters

With this parameter you can save all the parameter settings to the EEPROM. To do this, the parameter must have the value PWE = 1 when the transfer takes place.

5.2.3 General parameters

5.2.3.1 PNU 1000: instrument ID

The instrument ID consists of four ASCII characters, with the contents “S6xx”, whereby xx stands for the current level of the output stage (e.g. S606).

5.2.3.2 PNU 1001: manufacturer-specific error register

The assignment of the error register can be seen in the following table. The explanation of the individual errors can be found in the assembly & installation instructions for the servo amplifier.

Bit	Description	
0	Error F01:	Heatsink temperature
1	Error F02:	Overvoltage
2	Error F03:	Contouring error only with SERCOS
3	Error F04*:	Feedback
4	Error F05:	Undervoltage
5	Error F06*:	Motor temperature
6	Error F07*:	Auxiliary voltage
7	Error F08:	Overspeed
8	Error F09*:	EEPROM
9	Error F10*:	Flash-EEPROM
10	Error F11*:	Brake
11	Error F12*:	Motor phase
12	Error F13:	Internal temperature
13	Error F14*:	Output stage
14	Error F15:	I²t max.
15	Error F16:	Mains supply-BTB
16	Error F17*:	A/D-converter
17	Error F18*:	Ballast
18	Error F19:	Mains supply phase
19	Error F20*:	Slot error
20	Error F21*:	Handling error, plug-in card
21	Error F22:	Erdschluss
22	Error F23:	CAN-Bus off
23	Error F24:	Warning
24	Error F25:	Commuation error
25	Error F26:	Limit switch
26	Error F27:	AS-Option
27-30	Error F28 - F31*:	reserved
31	Error F32*:	System error

When the cause of the error has been cleared, the error state can be canceled by setting Bit 7 in the control word.
The error response of the PMCtendo DD4 to the reset will differ, depending on the error that has occurred:
For errors that are marked by an asterisk, setting the reset bit initiates a cold-start of the drive, whereby the PROFIBUS communication to this instrument will also be interrupted for several seconds. Depending on the circumstances, this break in communication may have to be separately handled by the PLC.
For the other errors, the reset leads to a warm start, during which the communication will not be interrupted.

A description of the individual errors and recommendations for removing them can be found in the installation manual.

5.2.3.3 PNU 1002: manufacturer-specific status register

The assignment of the bits for the status register can be seen in the following table:

Bit	Description
0	**Warning 1:** I^2t threshold exceeded (set, as long as I_{rms} is above the threshold)
1	**Warning 2:** Ballast power exceeded (set, as long as the set ballast power is exceeded)
2	**Warning 3:** Contouring error
3	**Warning 4:** Threshold monitoring (field bus) active
4	**Warning 5:** Mains supply phase missing
5	**Warning 6:** Software limit-switch 1 has been activated
6	**Warning 7:** Software limit-switch 2 has been activated
7	**Warning 8:** Faulty motion task has been started
8	**Warning 9:** No reference point was set at the start of the motion task
9	**Warning 10:** PSTOP active
10	**Warning 11:** NSTOP active
11	**Warning 12:** Motor default values were loaded (HIPERFACE® only)
12	**Warning 13:** Expansion card is not working properly
13	**Warning 14:** SinCos commutation not carried out
14	**Warning 15:** Speed - current table error INXMODE 35
15	**Warning 16:** Reserve
16	Motion task active (is set as long as a position control task is active - motion task, jogging, homing).
17	Reference point set (is set after a homing run, or when an absolute position (multi-turn) encoder is used. This is canceled when the amplifier is switched on, or when a homing run is started.
18	Actual position = home position (is set as long as the reference switch is activated).
19	InPosition (is set as long as the difference between the target position for a motion task and the actual position is smaller than PEINPOS. The InPosition signal is suppressed if a following task is started at the target position.
20	Position latch set (positive edge) – this is set if a rising edge is detected on the INPUT2 (IN2MODE=26) that is configured as a latch. This is canceled if the latched position is read out (LATCH16/LATCH32)
21	—
22	Position 1 reached (is set if the configured condition for this signal (SWCNFG, SWE1, SWE1N) is met. Depending on the configuration, this bit is set on exceeding SWE1, or going below SWE1, on reaching the InPosition window SWE1...SWE1N or on leaving the InPosition window SWE1...SWE1N.
23	Position 2 reached (see above)
24	Position 3 reached (see above)
25	Position 4 reached (see above)
26	Initialization completed (is set if the internal initialization of the amplifier is completed).
27	—
28	Speed = 0 (is set as long as the motor speed is below the standstill threshold VEL0).
29	Safety relay has been triggered (is set as long as the safety relay is open – AS-Option)
30	Output stage enabled (is set when software and hardware enables are set).
31	Error present (is canceled when the amplifier is switched on, or if the function “Cancel error” is called.

In the process data, Bits 16 to 31 of the manufacturer-specific status register are given out.
Warnings 3 and 4 can be reset through Bit 13 in the control word.

5.2.4 Position controller parameters

5.2.4.1 PNU 1250: velocity multiplier

This parameter is used to enter a multiplier for the jogging/homing velocity. The velocity for jogging/homing is given through PZD2 in the control word when jogging/homing is started.
The actual jog velocity is calculated according to the following formula:
$V_{Jog,vel.}(32Bit) = V_{Jog,PZD2}(16Bit) \times multiplier(16Bit)$
The defaultvalue is 1.

5.2.4.2 PNU 1251: axis type

This parameter is used to define to which type the axis belongs. If a 0 is given as the parameter value, it is a linear axis. 1 means a rotary axis.

5.2.5 Position data for the position-control mode

5.2.5.1 PNU 1300: position

Since the PMCtendo DD4 calculates all positioning operations internally only on an incremental basis, there are limitations on the usable range of values for distances that are given in SI units.
The range for the incremental position covers the values from -2^{31} to $(2^{31}-1)$.
The resolution that is determined by the PGEARO (PNU1258) and PGEARI (PNU1259) parameters and the variable PRBASE fix the sensibly usable range for positioning operations.
The variable PRBASE determines, through the equation $n = 2^{PRBASE}$, the number of increments per motor turn. The value of PRBASE can only be 16 or 20.
PGEARO contains the number of increments that must be traversed when the distance to be moved is PGEARI. The default values for PGEARO correspond to one turn.
The number of turns that can be covered are given as follows:
-2048..+2047 for PRBASE=16 and -32768..+32767 for PRBASE=20
The sensibly usable position range is derived as follows:

$-2^{31} * \frac{PGEARI}{PGEARO} \ldots (2^{31}-1) * \frac{PGEARI}{PGEARO}$ for PGEARI <= PGEARO or

$-2^{31} \ldots (2^{31}-1)$ for PGEARI > PGEARO

5.2.5.2 PNU 1301: velocity

The usable range for the velocity is not limited by the available data area. It is limited by the maximum applicable speed nmax, which is given by the speed parameter VLIM as the final limit speed for the motor.

The maximum velocity is thus given by:

$$\nu_{SI,\max} = n_{\max} \times \frac{PGEARI}{PGEARO} \times 2^{PRBASE}$$ with n_{max} in turns/second

or, in incremental units, as:

$$v_{incr.\max.} = n_{\max} \times 2^{PRBASE} \times \frac{250\mu s}{1sec} = \frac{n_{\max}}{4000} \times 2^{PRBASE}$$ with n_{max} in turns/second

5.2.5.3 PNU 1302: motion task type

Bit	Value	Meaning
0	0	The position value (Subindex 1) that is given is evaluated as an absolute position.
	1	The position value that is given is evaluated as a relative traversing distance. The two following bits then determine the type of relative motion.
1	0	If Bit 1and Bit 2 are set to 0 and Bit 0 set to 1, then the relative motion task is performed according to the “InPosition” bit.
	1	The new target position is given by the old target position plus the traversing distance. Bit 1 has priority over Bit 2.
2	0	If Bit 1and Bit 2 are set to 0 and Bit 0 set to 1, then the relative motion task is performed according to the “InPosition” bit.
	1	The new target position is given by the actual position plus the traversing distance.
3	0	no following task available
	1	There is a following task, but it must be defined through Subindex 0AH.
4	0	Change over to next motion task, with braking to 0 at the target position.
	1	Change over to next motion task, without standstill at the target position. The type of velocity transition is determined by Bit 8.
5	0	Change over to next motion task, without evaluating inputs.
	1	A following motion task is started by a correspondingly configured input.
6	0	Start the next motion task by Input State = low or if bit 7 = 1after the delay set in PNU 1309.
	1	Start the next motion task by Input State = high or if bit 7 = 1after the delay set in PNU 1309.
7	0	The next motion task is started immediately.
	1	The next motion task is started after the delay time set by PNU 1309 or, if Bit 6 = 1, previously by a corresponding input signal.
8	0	Only for following motion tasks and Bit 4 = 1: from the target position for the previous motion task onwards, the velocity is altered to the value for the following motion task.
	1	The change of velocity is made so that the velocity at the target position of the previous motion task matches the value given for the following motion task.
9	-	reserved
10		
11		
12	0	Accelerations are calculated according to the run-up/acceleration and run-down/braking times for the motion task.
	1	the deceleration/aceleration ramps are interpreted in mm/s²
13	0	The target position and target velocity of a motion task are interpreted as increments.
	1	The target position and target velocity are recalculated as increments before the start of the motion task. The parameters PGEARI and PGEARO are used for this purpose.
14	0	The programmed velocity is used as the velocity for the motion task.
	1	The velocity for the motion task is determined by the voltage present on analog input SW1 at the start of the motion task.
15	-	reserved

5.2.5.4 PNU 1304: acceleration time

This parameter defines the total time to reach the target velocity for the motion task.

5.2.5.5 PNU 1305: deceleration time

This parameter defines the total time to reduce the velocity to 0 at the target position.

5.2.5.6 PNU 1306: acceleration jolt limiting

This parameter defines the form of the acceleration ramp.
If a value ≠ 0 is entered here, then a sin²-ramp (S-curve) is used to reach the target velocity.
To employ sine²-ramps, the configuration variable SPSET has to be set to 1 (via the ASCII-channel or the ASCII-terminal in the setup software) and to be saved.

5.2.5.7 PNU 1307: deceleration jolt limiting

This parameter defines the form of the braking/deceleration ramp.
If a value ≠ 0 is entered here, then a sin²-ramp (S-curve) is used for braking/deceleration.

5.2.5.8 PNU 1308: next motion task

The motion task number of the motion task to be started can lie in the range 1 to 180 (motion tasks in EEPROM) or 192 to 255 (motion tasks in RAM).

5.2.5.9 PNU 1309: start delay

This parameter is used to set a delay time before the start of a motion task.

5.2.5.10 PNU 1310: copy motion task

This parameter can be used to copy motion tasks. The source motion task must be entered in the high-value portion of PWE (PZD 3 & 4) and the target motion task must be entered in the low-value portion of PWE (PZD 5 & 6).

5.2.5.11 PNU 1311: Position, 32 Bit floating decimal point format

(from SW – Version 0.07)
With this object the target position for motion task 0 (direct motion task, see ASCII – command O_P) can be set in 32 Bit Floating decimal point format (IEEE).
Right-of-comma positions will be truncated. This objekt is, aside from the data format, identical PNU 1300. The defaults are indicated in micrometers.
Use:
Controls that support only 16 Bit integer and 32 Bit floating decimal point.

5.2.5.12 PNU 1312: Velocity, 32 Bit floating decimal point format

(from SW – Version 0.07)
With this object the velocity for motion task 0 (direct motion task, see ASCII – command O_V) can be set in 32 Bit Floating decimal point format (IEEE).
Right-of-comma positions will be truncated. This objekt is, aside from the data format, identical PNU 1301.
Use:
Controls that support only 16 Bit integer and 32 Bit floating decimal point.

5.2.6 Setup mode: position

5.2.6.1 PNU 1350: homing

This parameter can be used to determine which type of homing run should be applied. The assignment can be seen in the following table:

PWE	Type of homing run
0	Reference point at the present position
1	Initiator with resolver zero mark
2	Hardware limit-switch resolver zero mark
3	Initiator without resolver zero mark
4	Hardware limit-switch without resolver zero mark
5	Zero mark / feedback unit
6	Reference point at the actual position
7	Hardware limit-switch with resolver zero mark
8	Absolute SSI-position

5.2.6.2 PNU 1351: homing direction

This parameter can be used to determine the direction of motion for homing runs. If a 0 is presented as the parameter value, then the direction of motion is negative; for a value 1 it is positive, and for a 2 it depends on the distance to the reference point in the direction in which the homing run started.

5.2.7 Actual values

5.2.7.1 PNU 1401: speed

The parameter value is the actual speed of the motor in increments / 250 µsec.

5.2.7.2 PNU 1402: incremental position: actual value

The parameter value is the actual position value in increments.

5.2.7.3 PNU 1403: SI-position: actual value

The parameter value is the actual SI-position value.

5.2.7.4 PNU 1414: Actual position, 32 Bit floating decimal point format

(from SW – Version 0.07)
With this object the actual position (see ASCII-command PFB) can be read in 32 Bit Floating decimal point format (IEEE).
Right-of-comma positions will not be shown. This objekt is, aside from the data format, identical PNU 1403.
Use:
Controls that support only 16 Bit integer and 32 Bit floating decimal point.

5.2.7.5 PNU 1415: Actual velocity, 32 Bit floating decimal point format

(from SW – Version 0.07)
With this object the actual velocity (see ASCII-command PV) can be read in 32 Bit Floating decimal point format (IEEE).
Right-of-comma positions will not be shown. This objekt is, aside from the data format, identical PNU 1404.
Use:
Controls that support only 16 Bit integer and 32 Bit floating decimal point.

5.2.8 Digital I/O-configuration

All settings for the digital inputs and outputs only become effective after being saved in the EEPROM and then switching off and on again, or making a cold start of the PMCtendo DD4. The significance of the functions can be seen in the user manual for the setup Software.

5.2.8.1 PNU 1450 .. 1453: function of the digital inputs

This parameter can be used to configure the digital inputs 1 to 4 individually.
The column “flank” describes the required signal at the digital input to actuate the corresponding function.

				Function n be employed with:			
PWE	**Function**	**Flank**	**Auxiliary variable (PNU 1454..1457)**	**PNU 1450**	**PNU 1451**	**PNU 1452**	**PNU 1453**
0	Off	-	-	x	x	x	x
1	Reset	↗	-	x			
2	PSTOP	↘Low-active	-			x	
3	NSTOP	↘Low-active	-				x
4	PSTOP+Intg.Off	↘Low-active	-			x	
5	NSTOP+Intg.Off	↘Low-active	-				x
6	PSTOP+NSTOP	↘Low-active	-			x	
7	P/Nstop+Intg.Off	↘Low-active	-			x	
8	SW1/SW2	High/Low	-	x	x	x	x
9	Fauftr_Bit	↗	-	x	x	x	x
10	Intg.Off	↗	-	x	x	x	x
11	1:1-control	High/Low	-	x	x	x	x
12	Reference	↗	-	x	x	x	x
13	ROD/SSI	High/Low	-	x	x	x	x
14	S_fehl_clear	↗	-	x	x	x	x
15	FStart_Folge	adjustable	-	x	x	x	x
16	FStart_Nr x	↗	Task number	x	x	x	x
17	FStart_IO	↗	-	x	x	x	x
18	Ipeak2 x	↗	of% Ipeak	x	x	x	x
20	FStart_TIPP x	↗	v in rpm	x	x	x	x
21	U_Mon.off	↗	-	x	x	x	x
22	FRestart	↗	-	x	x	x	x
23	FStart2_Nr x	↗	Task number	x	x	x	x
24	Opmode A/B	↗	Opmode No.	x	x		x
25	Zero_latch	↗	-	x	x	x	x
26	Zero pulse	↗	-		x		
27	Emergency stop	↘ Low	-	x	x		x
32	Brake	↗	-	x	x	x	x

5.2.8.2 PNU 1458/1459: function of the digital outputs

These parameters can be used to configure the two digital outputs individually.

PWE	Function	PWE	Function
0	Off	14	PosREG.3
1	n_act<x	15	PosREG.4
2	n_act>x	16	Next-InPos
3	Mains-BTB	17	Error/Warn
4	Ballast	18	Error
5	Sw_end	19	DC_Link>x
6	Pos.>x	20	DC_Link<x
7	InPos	21	ENABLE
8	list<x	22	Zero-pulse
9	list>x	23	Reserve
10	S_fault	24	Ref_OK
11	I²t	28	PosREG. 0
12	PosREG.1	29	PosREG. 5
13	PosREG.2		

5.2.9 Analog configuration

All settings for the analog inputs and outputs only become effective after being saved in the EEPROM and then switching off and on again, or making a cold start of the PMCtendo DD4. The significance of the functions can be seen in the user manual for the setup Software.

5.2.9.1 PNU 1500: configuration of the analog input functions

This parameter can be used to configure the two analog inputs together.

PWE	Function
0	Xsetp = SW1
1	N_setp = SW1, Isetp = SW2
2	unused
3	Xsetp = SW1, Ipeak = SW2
4	Xsetp = SW1 + SW2
5	Xsetp = SW1 * SW2
6	Electr. gearing
7	Icmd = SW1, nmax = SW2
8	Pcmd = SW1
9	Xcmd = SW1, Ferraris = SW2

5.2.9.2 PNU 1501/1506: configuration of the analog outputs

This parameter can be used to configure the two analog outputs individually.

PWE	Function
0	Off
1	n act
2	I act
3	n setp
4	I setp
5	S_fault
6	Slot

5.2.10 Manufacturer specific object channel (from PNU 1600)

The object catalogue was expanded by all existing parameters and commands from PNU 1600 on (reserved object range PNU 1600 - PNU 2000).
This object range is called SDO channel (SDO - Service Data Object). The SDO channel is expansible dynamically, new parameters will be added to the table **automatically**. The PNU is calculated by 1600 + ASCII object number.
Each of the object in the SDO channel is described by 8 subindexes (octet 3).

In the following, the structure of the subindexes is shown:

Subindex	0
short description	Number of entries
Unit	—
Access	—
Data-type	UNSIGNED8
Value range	0 ... 2^8-1
EEPROM	—

Subindex	1
short description	read/write a parameter
Unit	see corresponding ASCII-command
Access	see corresponding ASCII-command
Data-type	see corresponding ASCII-command
Value range	see corresponding ASCII-command
Defaultvalue	—
EEPROM	see corresponding ASCII-command

Subindex	2
short description	read lower limit
Unit	see corresponding ASCII-command
Access	Read only
Data-type	see corresponding ASCII-command
Value range	see corresponding ASCII-command
Defaultvalue	—
EEPROM	—

Subindex	3
short description	read upper limit
Unit	see corresponding ASCII-command
Access	Read only
Data-type	see corresponding ASCII-command
Value range	see corresponding ASCII-command
Defaultvalue	—
EEPROM	—

Subindex	4
short description	read defaultvalue
Unit	see corresponding ASCII-command
Access	Read only
Data-type	see corresponding ASCII-command
Value range	see corresponding ASCII-command
Defaultvalue	—
EEPROM	—

Subindex	5
short description	read object format
Unit	—
Access	Read only
Data-type	see corresponding ASCII-command
Value range	see corresponding ASCII-command
Defaultvalue	—
EEPROM	—

Desription:

The following object formats are possible:

0 Function (no parameters – write only)
1 Function (32-Bit parameter)
2 Function (32-Bit parameter with weighting 3)
3 8-Bit integer
4 8-Bit unsigned integer
5 16-Bit integer
6 16-Bit unsigned integer
7 32-Bit integer
8 32-Bit unsigned integer
9 32-Bit integer (weighting 3)

Subindex	6
short description	read object control data
Unit	—
Access	Read only
Data-type	UNSIGNED32
Value range	$0 \ldots 2^{32} - 1$
Defaultvalue	—
EEPROM	—

Description:

0x00010000 when altered, the variable has to be saved and the amplifier reset
0x00020000 variable will be saved in the serial EEPROM
0x00200000 variable is read-only, must not be written via PROFIBUS

Subindex	7,8
short description	reserved
Unit	—
Access	Read only
Data-type	UNSIGNED32
Value range	$0 \ldots 2^{32} - 1$
Defaultvalue	—
EEPROM	—

Caution!
Objects with format 0 (subindex 5) must not be accessed reading (response identification = 1)

6 Process data channel

The process data channel is used for real-time communication. This channel can effectively be divided into two telegram portions:

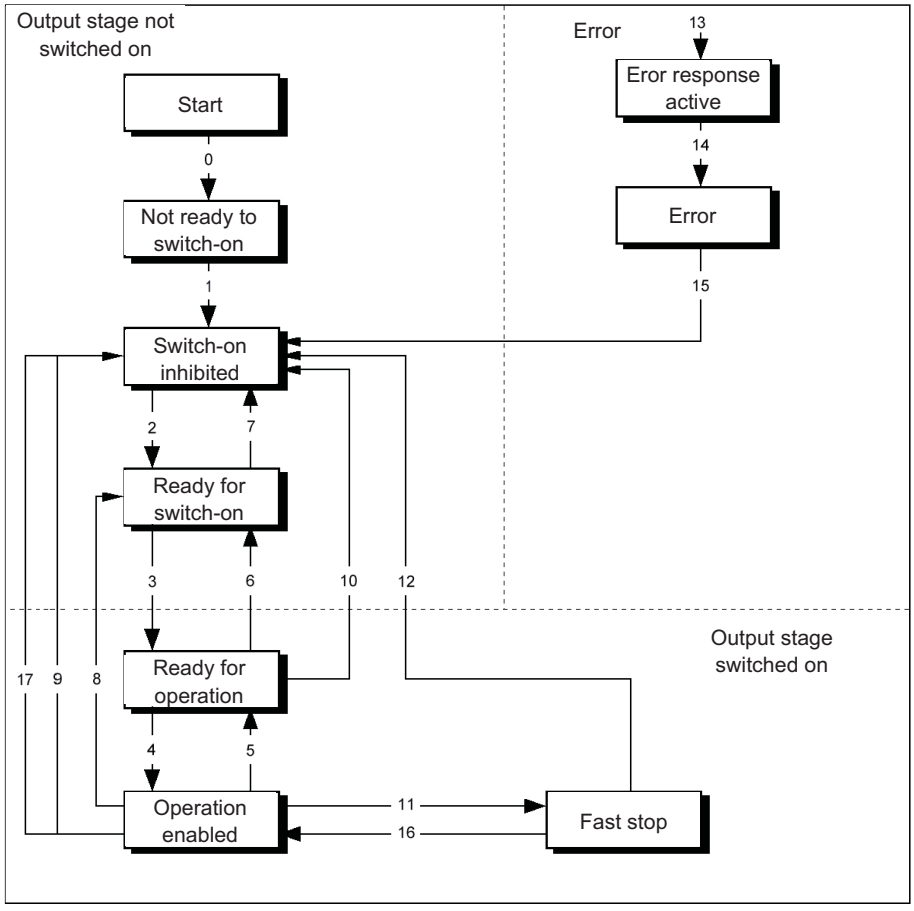
PZD1: Control word (STW) /Status word (ZSW) – instrument control
The control word and the status word are used to control the instrument and monitor the status of the instrument.

PZD2-6: Setpoint / actual values depending on the operating mode.
Setpoints and actual values such as position, velocity and current are exchanged in this section.

The availability of a process data channel is determined in the PROFIDRIVE drive profile. The significance of the process data is defined according to the operating mode. The process data that are used are determined in such a way that the real-time capability of this channel is optimally used. A central role is played by the parameter "Selector for operating modes" (see Chapter 5.2.2.3), that is used to choose between individual operating modes.
In the following, the instrument control is described first, and then the significance and functioning of the operating modes.

6.1 Instrument control

The control of the instrument is described with the aid of a status machine. The status machine is defined in the drive profile by a flow diagram for all operating modes. The following diagram shows the possible instrument states for the PMCtendo DD4.



The following table describes the instrument states and the transitions.

States of the status machine

State	Description
Not ready for switch-on	PMCtendo DD4 is not ready for switch-on. No operation readiness (BTB) is signaled from the amplifier software.
Switch-on inhibited	PMCtendo DD4 is ready for switch-on. Parameters can be transferred, DC-link (DC-bus) can be switched on, motion functions cannot be carried out yet.
Ready for switch-on	DC-link voltage must be applied. Parameters can be transferred, motion functions cannot be carried out yet.
Ready for operation	DC-link voltage must be switched on. Parameters can be transferred, motion functions cannot be carried out yet. Output stage is switched on (enabled).
Operation enabled	No error present. Output stage is switched on, motion functions are enabled.
Fast stop activated	Drive has been stopped, using the emergency stop ramp. Output stage is switched on (enabled), motion functions are enabled.
Error response active/error	If an instrument error occurs, the PMCtendo DD4 changes to the instrument state “Error response active”. In this state, the power stage is switched off immediately. After this error response has taken place, it changes to the state “Error”. This state can only be terminated by the bit-command “Error-reset”. To do this, the cause of the error must have been removed (see ASCII command ERRCODE).

Transitions of the status machine

Transition		Description
0	Event	Reset / 24V supply is switched on
	Action	Initialization started
1	Event	Initialization successfully completed, PMCtendo DD4 switch-on inhibit
	Action	none
2	Event	Bit 1 (inhibit voltage) and Bit 2 (fast stop) are set in the control word (command: shutdown). DC-link voltage is present.
	Action	none
3	Event	Bit 0 (switch-on) is also set (command: switch-on)
	Action	Output stage is switched on (enabled). Drive has torque.
4	Event	Bit 3 (operation enabled) is also set (command: operation enable)
	Action	Motion functions are enabled, depending on the operating mode that is set.
5	Event	Bit 3 is canceled (command: inhibit)
	Action	Motion functions are disabled. Drive is braked, using the relevant ramp (depends on operating mode).
6	Event	Bit 0 is canceled (ready for switch-on).
	Action	Output stage is switched off (disabled). Drive has no torque.
7	Event	Bit 1 or Bit 2 is canceled.
	Action	(Command: “Fast stop” or “Inhibit voltage”)
8	Event	Bit 0 is canceled (operation enabled -> ready for switch-on)
	Action	Output stage is switched off (disabled) - motor loses torque.
9	Event	Bit 1 is canceled (operation enabled -> switch-on inhibited)
	Action	Output stage is switched off (disabled) - motor loses torque.
10	Event	Bit 1 or 2 are canceled (ready for operation -> switch-on inhibited)
	Action	Output stage is switched off (disabled) - motor loses torque.
11	Event	Bit 4 is canceled (operation enabled -> fast stop)
	Action	Drive is stopped, using the emergency ramp. The output stage remains enabled. Setpoints are canceled (e.g motion block number, digital setpoint).
12	Event	Bit 1 is canceled (fast stop -> switch-on inhibited)
	Action	Output stage is switched off (disabled) - motor loses torque.
13	Event	Error response active
	Action	Output stage is switched off (disabled) - motor loses torque.
14	Event	Error
	Action	none
15	Event	Bit 7 is set (error -> switch-on inhibited)
	Action	Acknowledge error (depending on error – with/without reset)
16	Event	Bit 4 is set (fast stop -> operation enabled)
	Action	Motion function is enabled again.
17	Event	Bit 2 is canceled
	Action	Switch-on inhibited, output stage disabled

The state transitions are affected by internal events (e.g. switching off the DC-link voltage) and by the flags in the control word (Bits 0, 1, 2, 3, 7).

6.1.1 Control word (STW)

With the aid of the control word, you can switch from one instrument state to another. In the diagram for the state machine you can see which instrument states can be reached by which transitions. The momentary instrument state can be taken from the status word.
Several states may be passed through during a telegram cycle (e.g. Ready for switch on → Ready for operation → Operation enabled).
The bits in the control word can be (operating-) **mode-dependent** or **mode-independent**.
The following table describes the bit assignment in the control word.

Bit	Name	Commentary
0	Switch on	—
1	Inhibit voltage	—
2	Fast stop, switch-on inhibited	1 -> 0 drive brakes using emergency ramp, axis is disabled (See also ASCII-commands STOPMODE and DECDIS)
3	Operation enabled	—
4	Fast stop (inhibit rfg)	1 -> 0 drive brakes using emergency ramp
5	Pause (stop rfg)	Mode-dependent, 1 -> 0 stops motion
6	Setpoint enable	mode-dependent
7	Reset Fault	only effective with errors
8	Jogging (on/off)	mode-dependent
9	reserved	—
10	PZD (enable/inhibit)	—
11	Start homing run (edge)	mode-dependent
12	Manufacturer-specific	reset the position
13	Manufacturer-specific	acknowledge warnings
14	Manufacturer-specific	only position mode: Bit14 = 1: PZD section is interpreted as direct motion block (velocity 32-bit, position 32-bit, motion block type 16-bit Bit14 = 0: PZD section (HSW) is interpreted as motion block number
15	Manufacturer-specific	mode-dependent, digital speed

Depending on the bit combination in the control word, a corresponding control command is defined. The following table shows the bit combinations and also determines the priorities of the individual bits, in case several bits are altered in one telegram cycle.

Command	Bit 13	Bit 7	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Transitions
Shutdown	X	X	X	X	1	1	0	2, 6, 8
Switch-on	X	X	X	X	1	1	1	3
Inhibit voltage	X	X	X	X	X	0	X	7, 9, 10, 12
Fast stop (disable)	X	X	X	X	0	1	X	7, 10,11->12
Fast stop (enable)	X	X	0	1	1	1	1	11
Inhibit operation	X	X	X	0	1	1	1	5
Enable operation	X	X	1	1	1	1	1	4, 16
Reset error	X	1	X	X	X	X	X	15
Acknowledge warnings	1	X	X	X	X	X	X	-

Bits labeled with X are irrelevant.

Mode-dependent bits in the control word:

Mode	Bit 5	Bit 6	Bit 8	Bit 11
Position	**Motion block**: The parameter that is set in the motion block is used. **Setup operation**: The parameter that is set as a ramp for homing and jogging is used	Start a motion task with every transition edge (toggle bit).	Start jogging	Start homing
Digital speed	Drive brakes, using the preset speed ramp.	Setpoint enable	reserved	reserved
Digital current	reserved	Setpoint enable	reserved	reserved
Analog speed	reserved	reserved	reserved	reserved
Analog current	reserved	reserved	reserved	reserved
Trajectory	reserved	reserved	reserved	reserved

Priority of the Bits 6, 8, 11 in position-control mode: 6 (high), 11, 8 (low).

6.1.2 Status word (ZSW)

With the aid of the status word, the instrument state can be represented and the transmitted control word can be verified. If an unexpected condition is reported, as the result of a transmitted control word, then first of all the boundary conditions for the expected instrument state must be clarified (e.g. enable of the output stage – hardware + software, application of the DC-link voltage).

The bits in the status word can be **mode-dependent** or **mode-independent.**
The following table describes the bit assignment in the status word.

Bit	Name	Commentary
0	Ready for switch-on	---
1	Switched on	---
2	Operation enabled	---
3	Error	see ASCII command ERRCODE
4	Voltage inhibited	---
5	Fast stop	---
6	Switch-on inhibit	---
7	Warning	see ASCII command STATCODE
8	Setpoint / actual value monitoring	only in position-control mode: contouring error indicator
9	Remote	not supported, fixed to 1
10	Setpoint reached	only in position mode: In Position
11	Limit active	not supported at present
12	Mode-dependent	used in ASCII-mode
13	Mode-dependent	used in ASCII-mode
14	Manufacturer-specific	used in ASCII-mode
15	Manufacturer-specific	reserved

States of the status machine:

State	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Not ready for switch-on	0	X	X	0	0	0	0
Switch-on inhibit	1	X	X	0	0	0	0
Ready for switch-on	0	1	X	0	0	0	1
Ready for operation	0	1	X	0	0	1	1
Operation enabled	0	1	X	0	1	1	1
Error	0	X	X	1	X	X	X
Error response	0	X	X	1	0	0	0
Fast stop active	0	0	X	0	1	1	1

6.2 Operating modes

The selection of a new operating mode is described in detail in the chapter on the parameter channel. This procedure must be observed and adhered to.

WARNING
Appropriate precautionary measures against damage caused by faulty presentation of data formats or normalization of the setpoints must be taken by the user.

The possible operating modes are described below. Operating modes with a positive number (1,2) are defined in the drive profile. Operating modes with a negative number (-1,-2...) are labeled in the drive profile as being manufacturer-specific modes.

6.2.1 Positioning (operating mode 2)

PZD 1	PZD 2	PZD 3	PZD 4	PZD 5	PZD 6
STW	motion task no. or v_{setp}*	-	-	-	-
ZSW	n_{act} (16-bit)	actual position (32-bit)		manufacturer-specific status	-

*: for jogging/homing

Deviating assignment of the process-data sections with STW Bit 14=1:

PZD 1	PZD 2	PZD 3	PZD 4	PZD 5	PZD 6
STW	direct motion task: V_{setp} (32-bit)		position setpoint (32-bit)		motion block type
ZSW	n_{act} (16-bit)	actual position (32-bit)		manufacturer-specific status	-

Motion task number

The motion task number of the motion task to be started can lie in the range 1 to 180 (motion tasks in EEPROM) or 192 to 255 (motion tasks in RAM).

Actual speed (16-bit)

The representation of the 16-bit actual speed value is normalized to the parameter for overspeed VOSPD $n_{act16} = \frac{n_{act}}{VOSPD} \times 2^{15}$

Actual position (32-bit)

The range for the incremental position covers values from -2^{31} to $(2^{31}-1)$, whereby one turn corresponds to 2^{PRBASE} increments.

Manufacturer-specific status

In the process data, the upper 16 bits of the manufacturer-specific status register (PNU 1002) are made available. The numbering starts again from 0.
The significance of the status register bits can be seen in the table in Chapter 5.2.3.3.

Speed setpoint for a direct motion task

The usable range for the speed is not limited by the available data area. It is limited by the maximum achievable speed nmax, which is given by the speed parameter VLIM as the final limit speed for the motor.
The maximum speed is derived from the following formula:

$v_{SI,\max} = n_{\max} \times \frac{PGEARI}{PGEARO} \times 2^{PRBASE}$ or, as an incremental value, from:

$v_{incr.\max.} = n_{\max} \times 2^{PRBASE} \times \frac{250\mu s}{1sec} = \frac{n_{\max}}{4000} \times 2^{PRBASE}$, in each case with n_{max} in revs/sec

Position setpoint for a direct motion task

The PMCtendo DD4 calculates all positioning operations internally only on an incremental basis, so there are limitations on the usable range of values for distances that are given in SI units.
The range for the incremental position covers the values from -2^{31} to $(2^{31}-1)$.
The resolution that is determined by the PGEARO (PNU1258) and PGEARI (PNU1259) parameters and the variable PRBASE fix the sensibly usable range for positioning operations.
The variable PRBASE determines, through the equation $n = 2^{PRBASE}$, the number of increments per motor turn. The value of PRBASE can only be 16 or 20.
PGEARO contains the number of increments that must be traversed when the distance to be moved is PGEARI. The default values for PGEARO are 1048576 (PRBASE = 20) or 65536 (PRBASE = 16) and correspond to one turn.
The number of turns that can be covered are given as follows:
-2048..+2047 for PRBASE=16 and -32768..+32767 for PRBASE=20
The sensibly usable position range is derived as follows:

$-2^{31} * \frac{PGEARI}{PGEARO} \ldots (2^{31}-1) * \frac{PGEARI}{PGEARO}$ for PGEARI <= PGEARO, or

$-2^{31} \ldots (2^{31}-1)$ for PGEARI > PGEARO

Motion block type

The various types of motion block are described in Chapter 5.2.5.3.

6.2.2 Digital speed (operating mode 1)

PZD 1	PZD 2	PZD 3	PZD 4	PZD 5	PZD 6
STW	N_{Setp}	-	-		-
ZSW	n_{act}	-	incremental actual position 32-bit		manuf.-specific status

Deviating assignment of the process data sections with STW Bit 14=1:

PZD 1	PZD 2	PZD 3	PZD 4	PZD 5	PZD 6
STW	n_{Setp} (32-bit)		-		-
ZSW	n_{act} (32-bit)		incremental actual position 32-bit		manuf.-specific status

Deviating assignment of the process data sections with STW Bit 15=1:

PZD 1	PZD 2	PZD 3	PZD 4	PZD 5	PZD 6
STW	n_{Setp}	-	-		-
ZSW	n_{act}	-	position (20 bits/turn and 16 turns)		manuf.-specific status

Actual speed n_{act} (16-bit)

The representation of the 16-bit actual speed value is normalized to the parameter for the overspeed VOSPD $n_{act16} = \frac{n_{act}}{VOSPD} \times 2^{15}$

Actual position (32-bit)

The range for the incremental position covers values from -2^{31} to $(2^{31}-1)$.
Here one turn corresponds to 2^{PRBASE} increments.

Manufacturer-specific status

In the process data, the upper 16 bits of the manufacturer-specific status register (PNU 1002) are made available. The numbering starts again from 0.
The significance of the status register bits can be seen in the table in Chapter 5.2.3.3.

Speed setpoint n_{setp} (16-bit)

The 16-bit speed setpoint is normalized to the parameter for the overspeed VOSPD.

$$n_{setp16} = \frac{n_{setp}}{VOSPD} \times 2^{15}$$

Position

The actual position value is an incremental value with a resolution of 24 bits.
Her one turn corresponds to 2^{PRBASE} increments.
So $2^{24 - PRBASE}$ turns can be represented.

Speed values n_{act} (32-bit)

The digital speed values are converted according to the formula.

$$n_{setp/act}(\text{in rpm}) = n_{setp/act,dig.} \times \frac{60 \times 4000}{32 \times 2^{PRBASE}}$$

with 2^{PRBASE} = Increments per Motor turn, 60s/min,
4000 = Number of position controller cycles / sec.

6.2.3 Analog speed (operating mode -1) [in preparation]

PZD 1	PZD 2	PZD 3	PZD 4	PZD 5	PZD 6
-	-	-	-	-	-

6.2.4 Digital torque (operating mode -2)

PZD 1	PZD 2	PZD 3	PZD 4	PZD 5	PZD 6
STW	I_{setp}	-	-	-	-
ZSW	I_{act}	incremental actual position (32-bit, value range 24-bit)		manuf.-specific status	-

Actual position (32-bit)

The range for the incremental position covers values from -2^{31} to $(2^{31}-1)$.
Here one turn corresponds to 2^{PRBASE} increments.

Manufacturer-specific status

In the process data, the upper 16 bits of the manufacturer-specific status register (PNU 1002) are made available. The numbering starts again from 0.
The significance of the status register bits can be seen in the table in Chapter 5.2.3.3.

Digital current values (16-bit)

The digital current values are converted as follows: $$I[A] = \frac{digital\ current\ setpoint}{1640} \times I_{setp}$$

6.2.5 Analog torque (operating mode -3) [in preparation]

PZD 1	PZD 2	PZD 3	PZD 4	PZD 5	PZD 6
-	-	-	-	-	-

6.2.6 Electronic gearing (operating mode -4)

PZD 1	PZD 2	PZD 3	PZD 4	PZD 5	PZD 6
STW	-	-	-	-	-
ZSW	n_{act}	actual position (32-bit)		manuf. status	-

Actual speed (16-bit)

The representation of the 16-bit actual speed value is normalized to the parameter for the overspeed VOSPD $n_{act16} = \frac{n_{act}}{VOSPD} \times 2^{15}$

Actual position (32-bit)

The range for the actual position covers values from -2^{31} to $(2^{31}-1)$.
Here one turn corresponds to 2^{PRBASE} increments..

Manufacturer-specific status

In the process data, the upper 16 bits of the manufacturer-specific status register (PNU 1002) are made available. The numbering starts again from 0.
The significance of the status register bits can be seen in the table in Chapter 5.2.3.3.

6.2.7 ASCII-channel (operating mode -16)

PZD 1	PZD 2	PZD 3	PZD 4	PZD 5	PZD 6
STW	10 bytes of ASCII-data				
ZSW	10 bytes of ASCII-data				

The operating mode “ASCII-channel” is used for parameterizing the PMCtendo DD4.

With this channel, just as with any terminal program, ASCII data can be exchanged with the servo amplifier via the RS232 interface. The control of the communication is performed by handshake bits in the control and status words.
The assignment is as follows:

Bit 12: **Control word**
Any transition edge on this bit informs the PMCtendo DD4 that valid ASCII data are available in its process data input section, i.e. that with effect from this moment valid data must have been entered into the PZD transmission section PZD 2 - PZD 6 by the control system.
Status word
The PMCtendo DD4 confirms that it has accepted the ASCII data, by a transition edge on this bit.

Bit 13: **Status word**
The PMCtendo DD4 uses a “1” in this bit to signal that the ASCII buffer now contains valid data. A transition edge of Bit 14 in the control word STW can be used to make the PMCtendo DD4 write the buffer contents to the PZD reception section of the bus-master.

Bit 14: **Control word**
Any transition edge on this bit requests the PMCtendo DD4 to write the contents of its filled ASCII buffer to the receive process data of the bus master
Status word
The PMCtendo DD4 uses a transition edge on this bit to signal that the ASCII buffer data have been written to the process data.

When transmitting ASCII data, the following must be observed:

1. Every ASCII command must be terminated by the “CR LF” character sequence.
2. If the ASCII command (with CR LF) is shorter than the 10 characters that are available, then the rest of the telegram must be filled up with bytes with a content 0x00.
3. ASCII commands that are longer than 10 characters must be divided into more than one telegram, whereby a maximum of 30 characters can be sent before the buffer must be read out once.

When evaluating the responses to the transmitted ASCII command, the following must be observed:

1. The ASCII response is always terminated by an “End of Text” (EOT = 0x04) character.
2. Response telegrams can include less than 10 bytes of user data, without the response being concluded. The telegram must then be filled up with bytes with the value 0x00.
3. After reading out the buffer, Bit 13 of the status word is reset to “0”, until the buffer is filled again.
   The designation of the end of the ASCII response is in all cases “End of Text”.

6.2.8 Initial setting after switch-on (operating mode -126)

In this state, it is indeed possible to control the state machine, but motion functions cannot be initiated.

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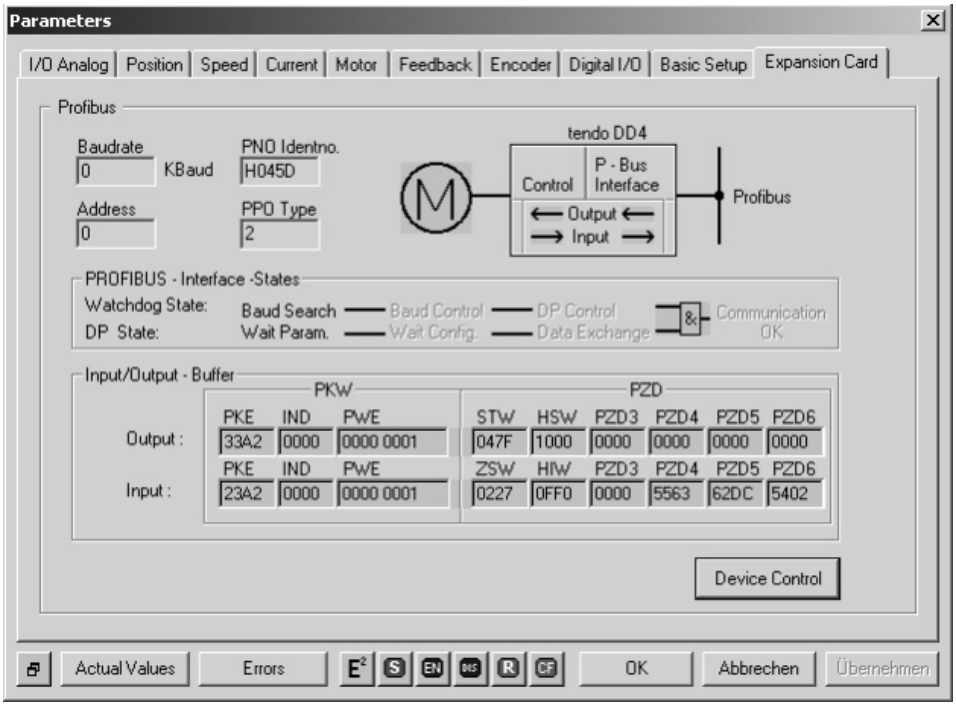
7 Setup software

7.1 Screen page PROFIBUS



On the menu page “Amplifier” the “PROFIBUS” screen will appear. Beyond this is a screen page that displays the PROFIBUS-specific parameters, the bus status, and the data words in the transmit and receive directions, as seen by the bus-master. This page is helpful when searching for errors and commissioning the bus communication.

Baudrate: The baud rate that is given by the PROFIBUS master is shown here.

PNO Identno.: The PNO identification is the number for PMCtendo DD4 in the list of ID-numbers of the PROFIBUS user organization.

Address: Station address of the amplifier. The address is set up on the screen page “Basic setup” (see function descriptions in the setup Software).

PPO type: PMCtendo DD4 only supports PPO-type 2 of the PROFIDRIVE profile.

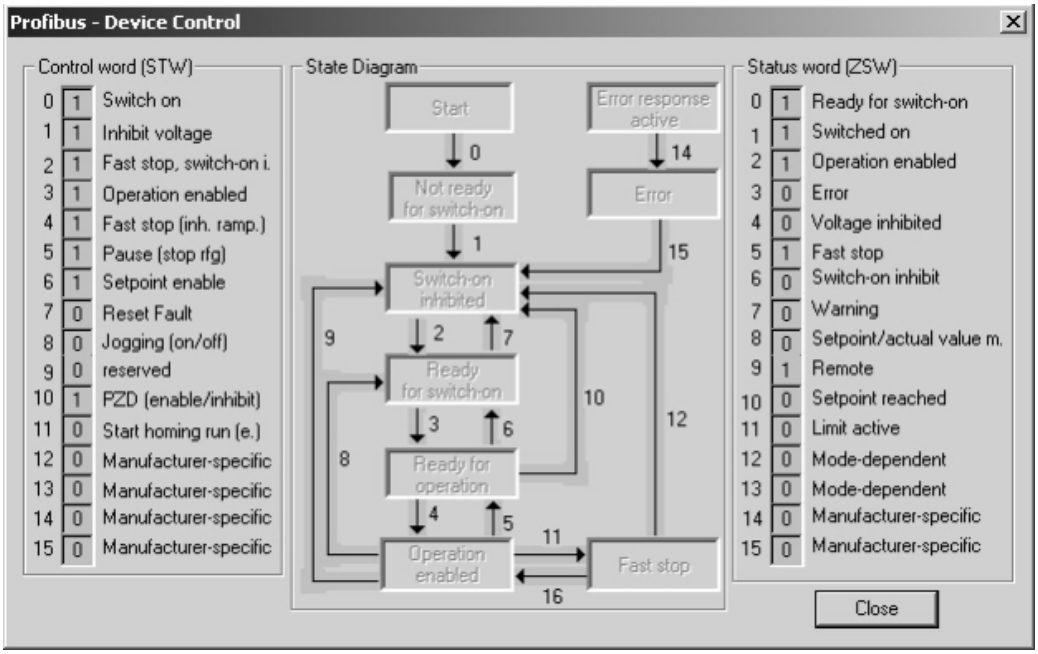
Interface states: Shows the present status of the bus communication. Data can only be transferred across the PROFIBUS when the “Communication OK” message appears.

Input: The last bus object that was received by the master.
Here PKE: Response to “write parameter operating mode”
PWE: Operating mode = 2 (OK-message)

Output: The last bus object that was sent by the master.
Here PKE: “write parameter operating mode” (PNU 930)
PWE: Word 2

The data for input/output are only transferred, if the threshold monitoring for the PMCtendo DD4 has been activated in the master’s hardware configuration.

7.2 Screen page PROFIBUS instrument control



On this screen page the single bits of the control word (SZT) and the status word (ZSW) are shown. The device status resulting from the status word is visualized in the status machine. The current status is shown as black, all other are grey. Additionally the previous status is visualized by emphasis of the number of the appropriate arrow.

8 Sample telegrams

8.1 Important communication parameter

1. EXTWD (PNU 1658): With this parameter, the observation time (watch dog) for the fieldbus-slot communication can be set. The observation is only active, if a value higher than 0 is assigned to EXTWD (EXTWD=0, observation switched off) and the output stage is enabled. If the set time ran off, without the timer being triggered newly, then the warning n04 (response monitoring) is generated and the drive is stopped. The amplifier remains ready for operation and the output stage enabled. Before a new driving command (setpoint) is accepted, this warning must be deleted (function CLRFAULT or INxMODE=14).

2. ADDR (PNU 918): With this command, the node address of the amplifier is set. When the address has been changed, all parameters should be saved to the EEPROM and the amplifier switched off and on again.
Since the modular structure of the PMCtendo DD4 400 as a multi-axis system requires its own addressing, there is the additional parameter **ADDRFB (PNU 2012)** for this series, with which a field bus address deviating from the internal device address can be defined. The setting takes place exactly as with ADDR.

3. AENA (PNU 1606): With this parameter, the state of the software-enable after switch-on can be defined. The software-enable allows an external control to enable/disable the output stage. For amplifiers with analog setpoints (OPMODE=1,3) the software-enable is set automatically after switch-on and the devices are ready for operation immediately (if hardware-enable is present). For all others, software-enable will be set to the value of AENA. The variable AENA has also a function when resetting the amplifier after an error (by digital input 1 or the CLRFAULT command). If an error can be reset by the software, the software-enable is set to the value of AENA after the error was cleared. In this way the behavior of the amplifier after a software-reset is similar to the switch-on reaction.

4. INPT (PNU 1904): With this parameter a delay for the in-position message can be set. With the start of a motion task the in-position message is deleted and the monitoring of the position is activated after expiration of the adjusted time. This function is particularly important for positioning procedures within the in-position window. In this case it is guaranteed that the in-position message is suppressed back for a defined time.

8.2 Zero telegram

At the beginning of communication via the parameter channel and after communication errors a zero telegram should be sent:

Byte 1	2	3	4	5	6	7	8
0000 0000	0000 0000	0000 0000	0000 0000	0000 0000	0000 0000	0000 0000	0000 0000
PKE		IND		PWE			

The PMCtendo DD4 answers, by likewise setting the first 8 byte of the telegram to zero.

8.3 Setting the operating mode

After switch-on or a reset the PMCtendo DD4 is in the operating mode -126, in which it cannot perform any motion functions. To be able to carry out positioning operations (motion tasks, jogging, homing), it must be set to the position-control mode.
The procedure to do this is as follows:

a) Set the control word Bit 10 (PZD1, Bit 10) to 0.
This invalidates the process data for the PMCtendo DD4.

Byte 9	10	11	12
xxxx x0xx	xxxx xxxx	xxxx xxxx	xxxx xxxx
STW		HSW	

b) Transmit a parameterization telegram for the operating mode setting.

Byte 1	2	3	4	5	6	7	8
0011 0011	1010 0010	xxxx xxxx	xxxx xxxx	0000 0000	0000 0000	0000 0000	0000 0010
PKE		IND		PWE			

The bits in the PKE section have the following significance:
Bit 0 to 10 = PNU 930, Bit 12 to 15 = AK 3 (see also Chapter 4.1.1)

The PMCtendo DD4 sends a response telegram with AK = 2 and mirrors (identical) the values for PNU and PWE.

c) Switch on the new operating mode by setting the control word Bit 10 to 1.
This validates the process data.

If, for example, point a) is not observed, the PMCtendo DD4 transmits a negative answer: (response ID=7)

Byte 1	2	3	4	5	6	7	8
0111 0011	1010 0010	0000 0000	0000 0000	0000 0000	0000 0000	0000 0000	0001 0001
PKE		IND		PWE			

The number that is transferred in the PWE section represents the error number, and can be looked up in the table in Chapter 4.1.1.2. In this case, error no. 17, “Task impossible because of operating state” will be signaled.

8.4 Enable the PMCtendo DD4

The hardware enable signal must be applied, as a precondition for enabling the PMCtendo DD4 via the PROFIBUS.
The enable can be made by setting the bit combination for the “Operation enabled” state in the control word.

Byte 9	10	11	12
xxx0 x1xx	0011 1111	xxxx xxxx	xxxx xxxx
STW		HSW	

The PMCtendo DD4 then reports back the corresponding state in its status word, or indicates a warning or error message.

Byte 9	10	11	12
xxxx xx1x	0010 0111	xxxx xxxx	xxxx xxxx
ZSW		HSW	

8.5 Start jog mode

Jog mode is started in a similar manner to homing. To start, Bit 8 STW must be set. The jog velocity is given by the product of the 16-bit main setpoint in PZD2 and the multiplier defined by parameter 1250. The sign of the main setpoint determines the direction of movement.

It is not necessary to have a reference point set for jogging.

8.6 Set reference point

Warning:
Take care that the position of the reference point permits the following positioning operations. The parameterized software limit-switches in the PMCtendo DD4 may not be effective. The axis could then drive up to the hardware limit-switch or the mechanical stop. There is a danger of damage being caused.

The control word Bit 12 = 1 defines the momentary position as being the reference point. The positioning functions are enabled. **The shifting of the zero point (NI-offset) is ineffective.**
The replay “Reference point set” is made through Bit 17 in the manufacturer-specific status register (PNU 1002) or Bit 1 (manufacturer status of the process data).

Conditions:
PNU930 ≠ -16
No motion function active manufacturer specific status, process data 5 bit 0

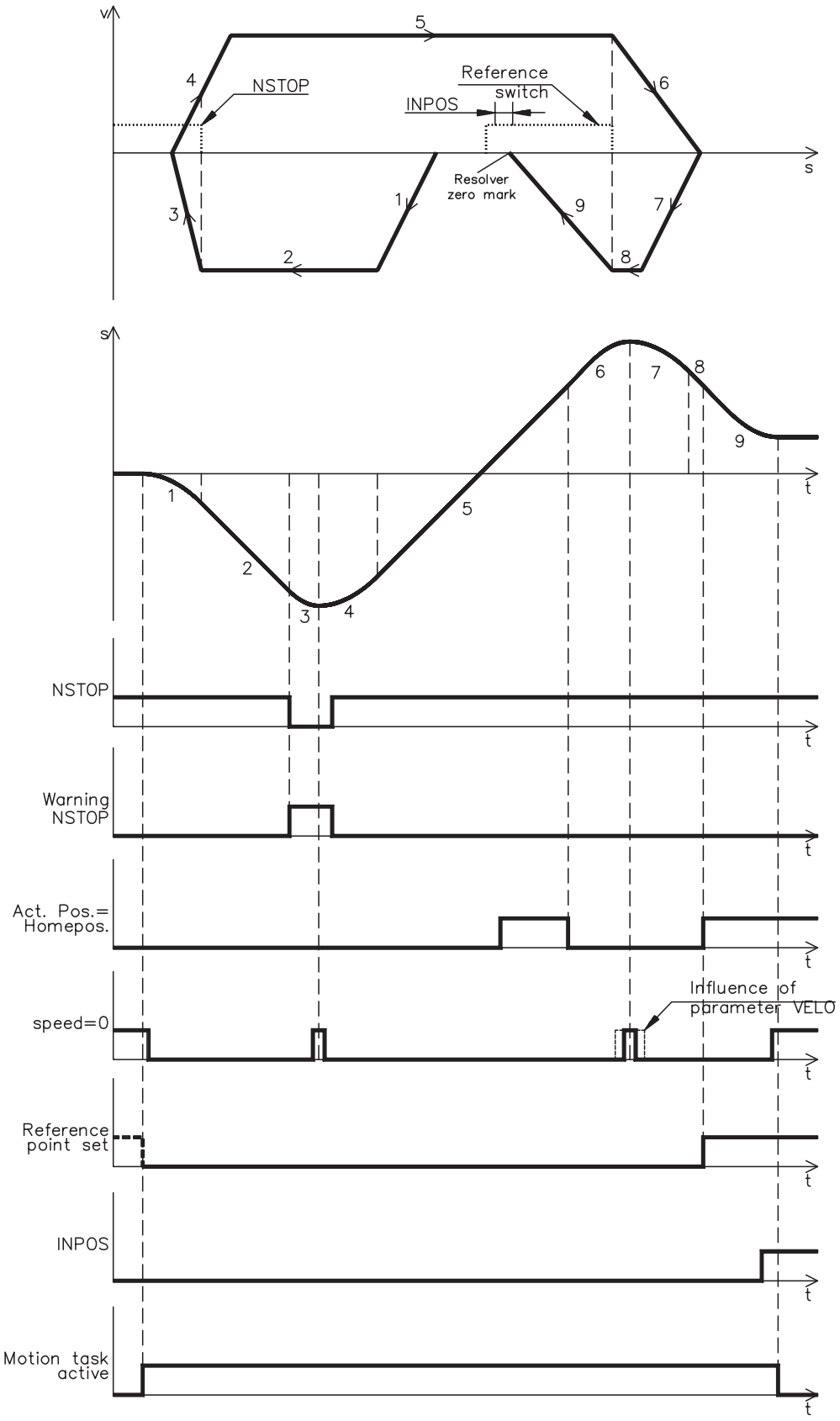
8.7 Start homing run

After switching on the 24V auxiliary voltage the system must first of all carry out a homing run.
Take care that the position of the machine zero point (reference point) permits the following positioning operations. The parameterized software limit-switches in the PMCtendo DD4 may not be effective. The axis could then drive up to the hardware limit-switch or the mechanical stop. There is a danger of damage being caused.
If the reference point (machine zero point) is approached too fast, with high moments of inertia in the system, then it might be overrun, and the axis could then drive up to the hardware limit-switch or the mechanical stop. There is a danger of damage being caused.

The homing run is started by STW, Bit 11 = 1. The start of the homing run is detected by a positive transition edge for Bit 11.
If Bit 11 is set to 0 again, before the reference point has been reached, then the homing run is canceled. Bit 12 ZSW remains at 0 (reference point not set).
A set reference point is a precondition for all the positioning functions of the linear axis.
The reference point switch is wired up to a digital input on the PMCtendo DD4.
Depending on the type of homing run, you can freely shift the zero crossing point of the motor shaft within one turn, by using the parameter “Zero-point offset” (NI-offset). Furthermore, you can fix the position value to be the reference point by using the reference offset.
After the homing run, the drive signals “InPosition”, thereby enabling the position controller.
The velocity for the homing run is transmitted with the main setpoint, as a 16-bit value. Multiplying this by the value of parameter 1250 determines the 32-bit speed. The sign is not evaluated.

Conditions :
State of the state machine = “Operation enabled”
No warning message (ZSW Bit 7 = 0)

The following diagram uses the homing run Type 1 (negative direction of motion, positive rotation, starting point in negative direction relative to the reference switch) as an example to illustrate the signal sequence of the relevant bits in the manufacturer-specific state.



After the homing run has been completed, Bit 11 STW must be set to 0 again.

Alternatively, the reference point can also be set at the actual position.
This can be achieved by setting Bit 12 STW, or by setting the homing run Type 0 with parameter 1350 and subsequent start of the homing run by Bit 11 STW .

8.8 Start a motion task

Motion tasks are started by a transition edge (positive or negative) at Bit 6 STW.
Bit 14 STW is used to decide whether a stored motion task or a direct motion task should be carried out.

Conditions:

Hardware enable is present.
Amplifier is in the “Operation enabled” state.
For linear axis: reference point is set.

Example: start the EEPROM motion task number 10:

Byte 9	10	11	12
0000 0100	0F*11 1111	0000 0000	0000 1010
STW		HSW	

* F stands for a transition edge, the state of Bit 6 STW also depends on the previous state.

By setting Bit 5 in the manufacturer-specific status, the amplifier indicates that it has accepted the motion task and is carrying it out.

8.9 Start a direct motion task

If the motion task data are to be freely defined, then a direct motion task must be used. In this case, the target position, velocity and type of motion task are transferred to the process data, together with the call of the motion task. If required, further parameters for this motion task (e.g. ramps) can be transferred previously by parameter tasks.

Target position 135000 µm

Velocity 20000 $\frac{\mu m}{s}$

Motion task type
- relative to actual position
- with following motion task
- without pause
- setpoint velocity for the following task should already be reached at the target position (only makes sense if there is no change of direction)
- use SI units

Byte 1	2	3	4	5	6
0100 0100	0F*11 1111	0000 0000	0000 0000	0100 1110	0010 0000
PZD1		PZD2		PZD3	
STW		v_{setp}			

Byte 7	8	9	10	11	12
0000 0000	0000 0010	0000 1111	0101 1000	0010 0001	0001 1101
PZD4		PZD5		PZD6	
s_{setp}				motion block type	

* F stands for a transition edge, the state of Bit 6 STW also depends on the previous state.

8.10 Polling a warning or error message

If a warning or error message is present, then parameter 1001 or 1002 can be interrogated to find out the number of the warning or error.

8.11 Writing a parameter

Parameter v_max is used as an example to show how control parameters are transmitted from the master to the PMCtendo DD4.

Parameter number: **1265** 100 1111 0001
Parameter value: **350000** µm/s 0000 0000 0000 0101 0101 0111 0011 0000

Byte 1	2	3	4	5	6	7	8
0011|0100	1111 0001	0000 0000	0000 0000	0000 0000	0000 0101	01010111	0011 0000
AK | PKE		IND		PWE			

Note: after an error has occurred in parameter transmission (AK = 7), a “Zero telegram” should be transmitted, i.e. the first 8 bytes of the transmit telegram from the PLC should be kept at 0, until the PMCtendo DD4 has responded with a zero telegram.

8.12 Read actual values

Cyclical actual value request
This PKW task switches on the reading of an actual value. The actual value will now be transmitted with each cyclical telegram – until a new PKW task is presented.
Telegram layout:

	Request	Response
PKE/AK	1	2
PKE/PNU	Parameter number of the actual values (1400..1413)	as transmitted
IND	0 = read	0
PWE	no significance	actual value

8.13 Write a parameter via the ASCII channel

The KP value for the current controller is to be set through the ASCII channel.
The command is then `MLGQ_0.985`. Here the understroke stands for an empty character. Since every telegram only has 10 positions available for the transmission of ASCII characters, the termination of the line (“CR LF”) must be transmitted in a second telegram.
Conditions:

ASCII mode is switched on (PNU 930 = -16)
Bit 13 STW = 0 (if necessary, toggle Bit 14 STW until Bit 13 ZSW = 0)

Procedure:

1. Write data to PZD 2..6 and invert Bit 12 STW

Byte 1	**2**	**3**	**4**	**5**	**6**
0001 0000	0000 0000	0100 1101	0100 1100	0100 0111	0101 0001
PZD1		PZD2		PZD3	
STW		“M”	“L”	“G”	“Q”

Byte 7	**8**	**9**	**10**	**11**	**12**
0010 0000	0011 0000	0010 1110	0011 1001	0011 1000	0011 0101
PZD4		PZD5		PZD6	
“_”	“0”	“.”	“9”	“8”	“5”

2. Wait for the transition edge on Bit 12 ZSW
3. Continue writing data to PZD 2..6 and invert Bit 12 STW

Byte 1	**2**	**3**	**4**	**5..12**
0000 0000	0000 0000	0000 1101	0000 1010	0000 0000
PZD1		PZD2		PZD3..6
STW		“CR”	“LF”	

4. Wait for the transition edge on Bit 12 ZSW
5. Wait until Bit 13 ZSW = 1
6. Invert Bit 14 STW
7. Wait until Bit 14 ZSW = 1
8. The servo amplifier sends a response telegram

Byte 1	**2**	**3**	**4**	**5**	**6**
0110 0010	0000 0000	0100 1101	0100 1100	0100 0111	0101 0001
PZD1		PZD2		PZD3	
ZSW		“M”	“L”	“G”	“Q”

Byte 7	**8**	**9**	**10**	**11**	**12**
0010 0000	0011 0000	0010 1110	0011 1001	0011 1000	0011 0101
PZD4		PZD5		PZD6	
“_”	“0”	“.”	“9”	“8”	“5”

9. Repeat steps 5 to 8 until a response telegram indicates “EOT”.

Byte 1	**2**	**3**	**4**	**5**	**6**	**7..12**
0000 0010	0000 0000	0000 1101	0000 1010	0000 0100	0000 0000	0000 0000
PZD1		PZD2		PZD3		PZD4..6
ZSW		“CR”	“LF”	“EOT”		

Note: The sequence of response telegrams shown above is only one of many possibilities (for the same response from the servo amplifier). Because of the transmission rate and the internal synchronization mechanism, it can happen that process data sections remain empty and so the response is broken into segments. This could possibly alter the number of response telegrams.

9 Appendix

Drive Handling Blocks for Communication between PMCtendo DD4 with PROFIBUS-DP Option and SIMATIC S7

The package consists of the following handling blocks:

FC21	Send data to the drive
FC22	Receive data from drive
FC100 DRVSTAT	STATUS information of the Profibus communication, transmission of status (ZSW) and control (STW) information to the servodrive, jogging and homing
FB102 DRIVEFSS	Function to store motion tasks to the servo drive
FC106 DRIVEFS	Call and process motion tasks
FC110 DRIVEPAR	Transfer of parameters, actual and setpoint values between the PLC and the servodrive

System requirements

- S7-315-2 DP or other S7-Controller with DP-Operation.

- Simatic Step 7, Version 2.1 or higher

How it works

The function blocks FC21 (Send) and FC22 (Receive) do the communication with the drives by using the user data block and the parameter data block. They use the parameters of the actual drive from the parameter data block to transfer data from the user data block to the output peripherie of the CPU and to read data from the input peripherie and transfer it to the user data block. In doing so they use the S7 system function SFC15 to send and the S7 system function SFC14 to receive data.

The function blocks FC100, FB102, FC106 and FC110 also access the user data block and provide interfaces for the user program.

The User Data Block

A user data block (DB101, DB102, ...) with the following design is needed for each axis:

Adress	Name	Comment	
n	reserved	Begin of Data Block	
...	...		
n + 16	reserved		
n + 18	PKES	Parameter-ID	
n + 20	INDS		PKW - Send Panel
n + 22	PWE1S	Parameter-Value 1	
n + 24	PWE2S	Parameter-Value 2	
n + 26	STW	Control Word	
n + 28	HSW	Main Setpoint	
n + 30	PZD3S		PZD - Send Panel
n + 32	PZD4S		
n + 34	PZD5S		
n + 36	PZD6S		
n + 38	PKEE	Parameter ID	
n + 40	PKWE		PKW - Receive Panel
n + 42	PKE1E		
n + 44	PWE2E		

n + 46	ZSW	Status Word	PZD - Receive Panel
n + 48	HIW	Main Actual Value	
n + 50	PZD3E		
n + 52	PZD4E		
n + 54	PZD5E		
n + 56	PZD6E		

(n = 2, 4, 6, … Begin of user data)

There can be parameters for several drives in one user data block. The number is limited by the maximum possible block size and by the max. number for the parameter NUDB of FC100. The low byte of this parameter is the number of the actual drive's data begin inside the user data block. It's max. value therefore is FFh.

The Parameter Data Block (example for 2 axes, DB100)

Adress	Name	Comment	
0	dbw0	Reserved	System Parameters (per DP-Master)
2	dbw1	Reserved	
4	dbw2	Reserved	
6	WDH	Reserved	
8	ppo_typ	Telegram type PPO2 (fixed)	
10	Bus_nr	Slave address of the drive (ADDR)	
12	DB_Nutzdaten	Number of User Data Block (101)	
14	Kom_st_wort	Begin of user data for slave 1 inside the user data block ('n', s.a.) (W#16#C)	
16	Peri_PKW	Startadress of PKW – peripheral range (W#16#0100)	
18	Peri_PZD	Startadress PZD - peripheral range (W#16#0108)	
20	ppo_typ2	Telegram type PP02	
22	Bus_nr2	Profibus slave number (ADDR)	
24	DB_Nutzdaten2	Number of User Data Block (102)	
26	Kom_st_wort2	Begin of user data (W#16#C)	
28	Peri_PKW2	Start adress PKW - peripheral range (W#16#0114)	
30	Peri_PZD2	Start adress PZD - peripheral range (W#16#011C)	

How to Handle

To use one of the functions it is mandatory to call the FC100. FC100 must be called first. Out of the functions FC101 to FC110 only those FCs/FBs must be called that are used. If FB102 is used, make sure that the call of FC110 that axis is skipped, since FC110 is used by FB102. All calls of FCs/FBs are made absolutely. Between the call of the FC100 and the calls of FC101 to FC110 no other function block is allowed to use the scratch flags MW200 – MW254. When processing alarms, the scratch flag area MW200 – MW254 bust be saved and reloaded.

Seperate function block calls, beginning with the FC100, are required for each drive. Only one task at a time can be started per drive. The next task can not be started, before the previous one is finished and BUSY = 0. If data words are declared as parameters to the FCs, they are placed in the parameterized user data block(FC100 NUDB).

Please notice that due to the change of the data address system of the S7 (byte wise instead of word wise as for S5) the right byte of the parameter NUDB of FC100 must be interpreted differently. Here half the value of the start data word is required. However in the parameter data block the start data word is required. Start data word means that address, where the data for the particular drive starts inside the user data block. For the example above it means 'n' for the parameter Kom_st_wort inside the parameter data block and 'n/2' for the right byte of the paramter NUDB (s.a. description of the FC100). The FC22 must be called before the FC21! The FC22 and FC21 should be called directly after the calls oft the handling blocks and within the same function block (FC, FB, OB).

Description of the Handling Blocks

FC21 (Send)

Inputs:		
DBPA	Integer	Number of the parameter data block
SYPA	Integer	reserved
SLPA	Integer	Start adress of the current drive parameters inside the parameter data block.

The FC21 must at least be called once per drive in every PLC cycle.

FC22 (Receive)

Inputs:		
DBPA	Integer	Number of the parameter data block
SYPA	Integer	reserved
SLPA	Integer	Start adress of the current drive parameters inside the parameter data block

The FC22 must at least be called once per drive in every PLC cycle.

FC21 and FC22 access the same parameter set and must be parametrized identically for one axis. FC22 must be called before FC21.

FC100 DRVSTAT

The FC100 establishes the communication beteween the user data block and the other handling blocks of the package for the parametrized axis. Furthermore it does:

- transmit the control word (except bit 6 and bit 14)
- provide the status word of the drive
- display the Profibus communication status.

Technical Data:	
Block Name:	DRVSTAT
Flags Used:	MW200-MW254
Access to:	DB User Data

Function of the parameters of FC100

Inputs:		
NUDB	word	left byte: Number of the user data block for the PROFIBUS communication right byte: Start data word of the user data of the corresponding drive
STW	word	control word to the drive except Bit6 and Bit14 (which are controlled by FC106)

Outputs:		
ZSW	word	Status Word as defined by PROFIDRIVE-Profile
KFEH	bool	no function
BUSY	bool	no function
OFEH	bool	no function
MFEH	bool	no function

Static Parameter:		
STAT	word	internal FC flag word for functions of the package DRIVE FC

FB102 DRIVEFSS

Together with an instance data block the FB102 is used to transfer motion task data for the PMCtendo DD4. The method is as follows:

Bit 15 of the select parameter WAHL determines if a sample motion task is transferred to the local motion task no. 0. Inside this motion task individual motion parameters can be changed. After the changes the complete motion task is transferred to motion task with the number FSNrZ in the drive. If this transfer is not successful bit 15 of the parameter WAHL will be set. The bits of WAHL not set back to 0 will show, which parameter could not be written.

Please note: When FB102 is started (SEND = 1) the call of FC110 must be skipped in the program sequence, since FC110 is used by FB102. FC110 must not be used to read or write parameters, before the SEND bit of FB102 is set back.

Technical Data:	
Name:	DRIVEFS
Flags used:	MW200-MW254
Access to:	DB User Data, Instance Data Block

Function of the Parameters of FB102

Inputs:		
POSI	dword	position for motion task, Bit0 in WAHL
VSOL	dword	speed for motion task, Bit1 in WAHL
FART	word	type of motion task, Bit2 in WAHL
RACC	word	acceleration ramp, Bit3 in WAHL
RDEC	word	deceleration ramp, Bit4 in WAHL
RACC2	word	jerk limitation for acceleration, Bit5 in WAHL
RDEC2	word	jerk limitation for deceleration, Bit6 in WAHL. Since firmware version 2.00 times are discretionary. If different from 0 the drive will follow a $\sin^2$ ramp (s-curve), if the configuration allows it.
TDEL	word	delay time for the next motion task, Bit7 in WAHL
FFOL	byte	number of the next motion task, Bit8 in WAHL
FSNrQ	byte	number of the source motion task; is used, when Bit15 of WAHL = 1
FSNrZ	byte	number of target motion task
SEND	bool	start transmission

Outputs:		
AKTI	bool	FB 102 is running

Static Parameters:		
STFB	word	Statusdisplay for this function block
WAHL	word	binary word to select parameters to be written; for interpretation see above; Bit 15 selects if a motion task is completely overwritten by the direct motion task (= 0) or changed (= 1); choice is done by setting the corresponding bit.
STAT	word	Status for all function blocks, same as FC100 STAT
REDY	bool	writing motion block finished
FAUL	bool	error occured, error position -> change of bits in WAHL

FC106 DRIVEFS

FC106 selects a motion task and starts its execution. This is done either with data from the drive's memory (no.s 1 – 180 EEPROM, 192 – 255 RAM) or as a direct motion task. In the latter case data for the direct drive parameters is needed.

With linear axes this function will not be executed before a homing sequence is finished successfully, i.e. the reference point is set.

To be able to run any motion task the drive must be switched to position mode (PNU 930 = 2).

Technical Data:	
Name:	DRIVEFS
Flags used:	MW200-MW254

Function of the Parameters of FC106

Inputs:		
Fahrsatznummer	word	number of motion task: 0 – direct motion task, 1..180 EEPROM, 192..255 RAM – motion task
Direkt_FSart	word	type of direct motion task
Direkt_vsoll	dword	32-Bit - Speed setpoint for direct motion task
Direkt_ssoll	dword	32-Bit - Position setpoint of direct motion task
Start	bool	start of a motion task with 0->1 edge, 0 - signal before the motion task is finished will interrupt it(1)
VELO	word	Speed (16 Bit) for jogging and homing, is directly copied to PZD2. The resulting velocity depends from a multiplication with the value of PNU 1250.

(1) The source codes of the handling block package include a version of the FC106 (fc106_t), that starts a motion task with every falling and rising edge of the start signal. When using this version, bit 4 (Fast Stop) or bit 5 (Pause) of the control word must be used to interrupt a motion task. The control word (except bits 6 and 14) is controlled by FC100.

Outputs:		
Istdrehzahl	word	actual speed in rpm related to parameter VOSPD
Istposition	dword	incremental actual position depending on PRBASE
HerstStatus	word	manufacturer specific status word

Static Parameters:		
MODUS	word	Operating mode of servodrive as per PROFIDRIVE profile. This parameter has to be provided with data by the user. If this value is unequal to 2, no motion can be started through this function block and no actual values can be read from this function block.
STAT	word	same flag word as parameterized for FC100 STAT

FC110 DRVPAR

The FC110 is used to read and write the parameters of the servodrive according to the documented list of parameter numbers (PNUs).

Technical Data:	
Name:	DRVPAR
Flags used:	MW200-MW254

Inputs:		
PANR	word	Parameter number according to parameter number table
PIDX	byte	Subindex to parameter numbers, used only with manufacturer specific PNUs starting at PNU 1600, otherwise 0
REWR	bool	Read/Write - Flag: 0 – read a parameter, 1 – write a parameter
STRT	bool	1 - Start a read/ write task, 0 cancels a task

Outputs:
none

Static Parameters:		
AKTV	bool	Active display for task, 1 = active
FERT	bool	Return message: 1 = parameter could be processed
FEHL	bool	Fault/error display: 1 = Parameter could not be read or written. In this case there is an error number in PALO (for evaluation, see the documentation). When an error occurs, a NULL telegram must be written (PTYP = 3).
PTYP	byte	Parametertype: 2 – double word parameter (all parameters in the servodrive), the parameter number is coming from PANR, 3 = write only, write a NULL telegram, i.e. all data for the PKW Channel are set to 0 and transmitted to the SERVOSTAR. A NULL telegram should be written: - when starting the communication to drive - after an error occured (-> FEHL) - when changing between read and write of one parameter
PAHI	word	more significant word of the parameter value
PALO	word	less significant word of the parameter value
STAT	word	same flag word as parameterized for FC100 STAT

10 Index

A
- abbreviations . . . 7
- acceleration time . . . 28
- actual position value
  - incremental . . . 30
  - SI-units . . . 30
- analog inputs . . . 32
- analog outputs . . . 32
- Antwortkennungen . . . 16
- axis type . . . 27

B
- baud rate . . . 24

C
- control word . . . 38
- Copyright . . . 2

D
- data format, parameter . . . 18
- deceleration time . . . 28
- default parameters . . . 24
- digital inputs . . . 31
- digital outputs . . . 32

E
- error numbers . . . 17
- error register . . . 25

G
- Gesamtdokumentation . . . 9

H
- homing . . . 50
- homing direction . . . 30
- homing type . . . 30

I
- incremental position . . . 27
- installation . . . 11
- instrument control . . . 35
- instrument ID . . . 25
- instrument profile . . . 15
- interface modules . . . 12

J
- jog mode . . . 49
- jolt limiting
  - acceleration . . . 29
  - deceleration . . . 29

M
- motion task
  - copy . . . 29
  - start . . . 52
  - type . . . 28

N
- next motion task . . . 29

O
- operating modes . . . 39

P
- parameter channel . . . 16
- parameter description . . . 22
- parameter ID . . . 16
- parameter numbers . . . 19
- parameter value . . . 18
- parameterization of the amplifier . . . 18
- PNU list . . . 19
- position data . . . 27
- process data channel . . . 18
- PROFIDRIVE profile number . . . 24

R
- read actual values . . . 53
- read/write amplifier parameter . . . 19
- response IDs . . . 16

S
- safety instructions . . . 5
- sample telegram . . . 48
- saving . . . 24
- set reference point . . . 49
- Setup . . . 13
- setup software . . . 45
- speed . . . 30
- standard function blocks . . . 13
- start delay . . . 29
- status machine . . . 36
- status register . . . 26
- status word . . . 39
- subindex . . . 17

V
- velocity . . . 27
- velocity multiplier . . . 27

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